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PROCEDURES FOR CONDUCTING THE AIR FORCE WEAPONS LABORATORY STANDARD SKID RESISTANCE TEST

George D. Ballentine, et al

Air Force Weapons Laboratory
Kirtland Air Force Base, New Mexico

September 1973

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George D. Ballentine
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AIR FORCE WEAPONS LABORATORY
Air Force Systems Command
Kirtland Air Force Base
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George D. Ballentine, Maj, USAF, Phil V. Compton, Maj, USAF

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(Distribution Limitation Statement A)

Detailed procedures for conducting the standard runway skid resistance test are included for use in implementing an Air Force-wide Skid resistance testing program. Each step in the testing procedure, ranging from calibration of the test equipment to recording of field data is discussed. Copies of all special forms required for recording data are included. Use of these forms greatly facilitates the use of computer analysis package, which has been prepared to analyze data gathered in the standard test. When the test is conducted according to procedures in this report, a great deal of information is gained about the hydroplaning potential of the runway surface. The test, therefore, represents a significant advance in the state-of-the-art of measuring runway skid resistance. Results of the test indicate directly if corrective action is required to improve runway skid resistance properties, thereb giving information unavailable from any other source.

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14. KEY WORDS	LINK A		LINK B		LINK C	
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Aircraft hydroplaning potential						
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FOREWORD

This research was performed under Program Element 63723F, Project 782M, Task 04.

Inclusive dates of research were 5 February 1971 through 30 June 1973. The report was submitted 10 July 1973 by the Air Force Weapons Laboratory Project Officer, Major George D. Ballentine (DEZ).

This technical report has been reviewed and is approved.

GEORGE D. BALLENTINE
Major, USAF
Project Officer

OREN G. STROM
Lt Colonel, USAF
Chief, Aerospace Facilities Branch

WILLIAM B. LIDDICOET
Colonel, USAF
Chief, Civil Engineering Research Division

ABSTRACT

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INTRODUCTION

1. BACKGROUND

The Air Force Weapons Laboratory's (AFWL) standard skid-resistance test for potential hydroplaning problems on airfield runways has been under development for some time, research is continuing. The standard test is a major development that grew out of Project Combat Traction, a joint USAF-NASA program that initiated USAF research into the methods for quantifying potential hydroplaning situations. The test procedure is designed to evaluate the skid resistance and hydroplaning characteristics of a runway surface.

Research in the skid resistance area was initiated because of the large number of skidding/hydroplaning accidents involving high-speed jet aircraft. A means was sought to recognize potential hydroplaning situations prior to loss of a valuable aircraft. The standard skid resistance test developed by AFWL provides the best available means for classifying runways according to their hydroplaning potential. Additionally, it provides a basis from which to reach a decision on the need for rubber removal, and also gives approximate runway condition rating (RCR) values for runways tested.

The AFWL standard skid resistance test uses the British-developed Mu-Meter and the diagonally braked vehicle (DBV) to evaluate the skid resistance/hydroplaning characteristics of runway surfaces. The standard test consists of field measurements of the pavement skid resistance/hydroplaning properties with both pieces of equipment under dry conditions and under standardized wet conditions. Water is applied to test sections of the pavement using flightline fire department water tankers carefully calibrated to discharge known water quantities which simulate a rainfall rate of 0.6 to 0.8 inch per hour.

Data are gathered on temperature and wind conditions during the test and on both longitudinal and lateral pavement slopes. These data, along with information obtained by use of the Mu-Meter and DBV, are recorded on specially prepared forms for entry onto computer cards. The forms are designed in such a way that the field data can be keypunched directly without recopying or transcribing in any way.

A computer analysis package has been prepared to perform a complete analysis of all data gathered in the standard test. Input to this analysis package consists of all field data keypunched onto computer cards. Output consists of a written report with summary tables showing the skid resistance properties of the pavement tested and a number of plotted curves showing the relationships between the significant variables.

Detailed procedures for conducting the AFWL standard skid resistance test and instructions for recording all necessary data are contained in the sections that follow. A copy of each specially prepared form necessary for recording data is contained in appendix II.

Separate publications will be released in the near future describing the operation of the computer program and, in detail, the instrumentation of the DBV. For interim purposes, brief instructions on use of the computer program are included with this publication. An operational check list for use with the DBV is also included in appendix II; this form can be reproduced for use while gathering field data.

2. COORDINATION PRIOR TO TESTING

The test program is generally conducted at the request of the major air command. A letter to the major command establishing the proposed schedule and listing the support that will be required at each base should be written early in the initial planning.

To secure the best results and to encourage maximum cooperation from base personnel where a test is being conducted, a thorough briefing before the test is absolutely essential. This briefing is generally set up the afternoon before the day of testing. The following base personnel should be included at such a briefing.

Base project officer for the test
Base civil engineer
Director of operation (or base ops officer)
Fire chief
Duty chief during test (if possible)
Transportation officer

The following items should be covered at the briefing:

a. Purpose of the test and expected results.

b. General outline of how the test will be run.

(1) Specific areas of the runway to be tested (type of test sections and reasons selected).

(2) Equipment to be used (photographs of DBV and Mu-Meter may be helpful here).

c. Support required from the base to include:

(1) Closure of the runway for a total of 7 daylight hours. The runway time is broken into a 2-hour and a 5-hour block of uninterrupted time intervals. A 1- to 2-hour period is required between the two time periods to service vehicles.

(2) A base vehicle for the test conductor to use during the actual testing.

(3) Flightline vehicle with driver to maintain radio control with the tower. (This could be the duty fire chief, base ops, etc.)

(4) Water truck(s) and crew. (See section III for specific requirements of the trucks.) Driver and pump operator must be furnished with the truck.

(5) A rapid water refill capability near the flightline for water truck(s) (minimum capacity at 3000 gallons per 15 minutes).

(6) Copies of runway system drawings showing layout, longitudinal and transverse slopes, and brief construction and maintenance history of the runway(s) to be tested.

(7) Secure overnight storage space for test equipment (near flightline, if possible).

(8) Tire changing and mounting facilities for test tires on DBV.

(9) Removal of BAK-9 and BAK-12 runway barriers from the runway while test is being accomplished.

(10) Premium gasoline and maintenance (if required) capability for DBV and Mu-Meter truck.

d. Description and distribution of the report that will be prepared.

A debriefing may be arranged, time permitting, to give the command section a general appraisal of the runway's performance. No specific number should be provided until the data have been analyzed; however, a qualitative overview can be made, such as excellent, good, fair, or poor, and a general statement can be made if there appears to be a potential skidding problem.

SECTION II

SELECTION AND LAYOUT OF TEST SECTIONS

1. GENERAL REQUIREMENTS

The AFWL standard test is conducted on preselected 2000-foot strips of pavement surface. To get skid resistance data that is representative of all areas of the runway, test strips should be laid out in each of the following areas.

a. Touchdown area, primary end.

b. Touchdown area, secondary end.

c. Central interior areas of runway (traffic area).

d. Runway edge (nontraffic area).

If a combination of surface materials are present on a given runway (e.g., portland cement concrete touchdown area at one end or asphaltic concrete overlays on portions of the runway), test strips should be laid out in such a way that data will be obtained on each surfacing material present. Likewise, if drainage conditions differ significantly between sections of the runway test strips should be selected to give representative data from all extremes.

In touchdown areas, test strips should be selected to give representative data from any rubber-coated areas present. On both portland cement and asphaltic concrete runways, one test strip should be placed at the edge of the runway where little or no traffic has passed. Data from this test strip are indicative of the surface texture of the pavement surface without the polishing effects of traffic.

2. TYPICAL LAYOUT

Figure 1 shows a typical layout of test strips on a runway surfaced throughout with the same material. Precise locations of test strips, laterally and longitudinally, should not be determined exactly from this figure, however; each runway presents a unique case, and test strips must be located on the basis of an on-site inspection and determination of which areas of the runway are representative of conditions that exist. The number of test strips shown in figure 1 is considered the minimum necessary to adequately characterize an average runway.

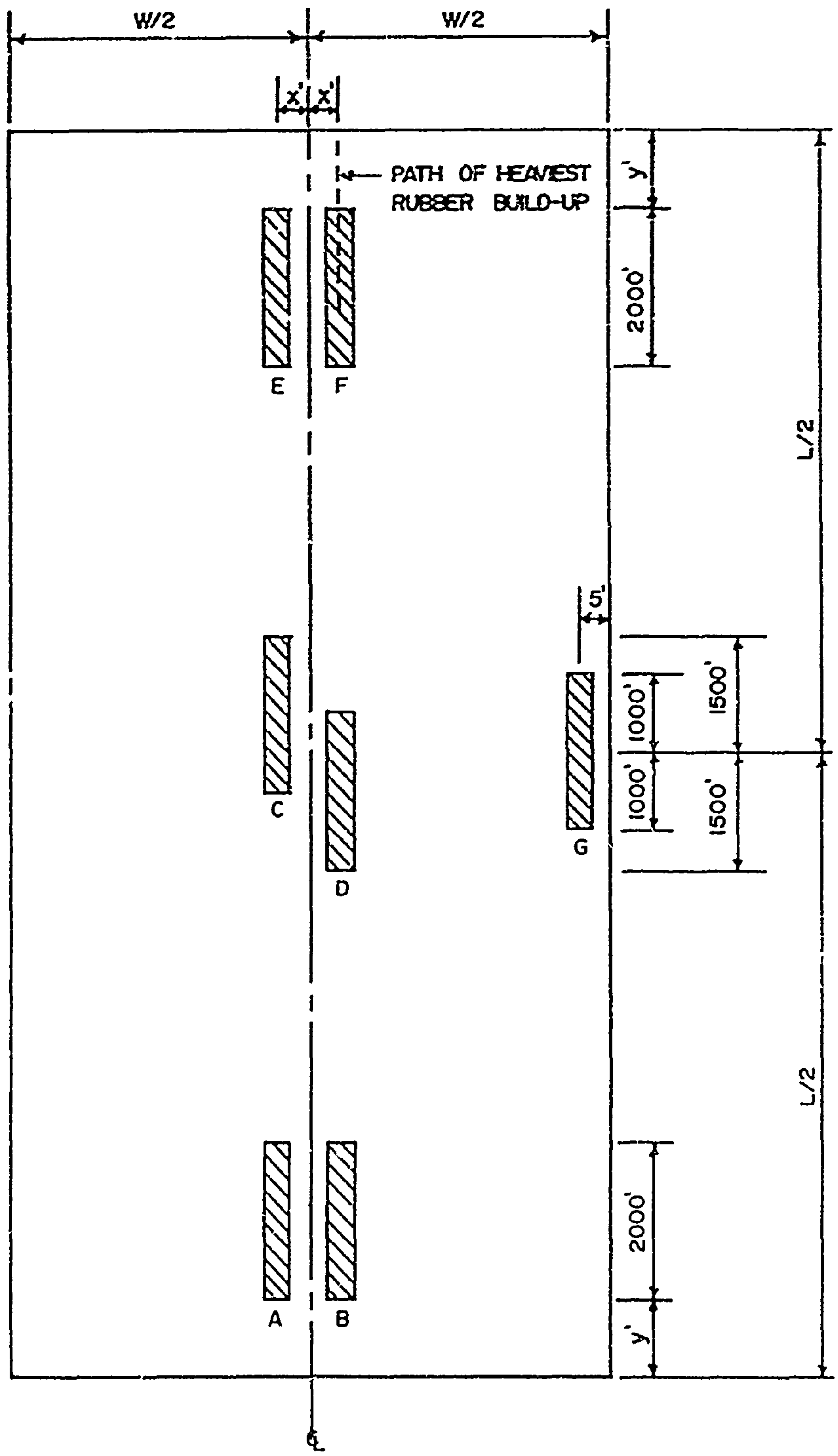


Figure 1. Typical Layout of Test Strips

In some cases, a single test section on the secondary runway end may be adequate if the rubber buildup is small. A facsimile of figure 1 is reproduced in appendix II; this form can be used to record the actual location of test sections during the testing sequence.

To establish the location of the test areas to be used, the test conductor must make a full-length inspection of the runway surface. If possible, it is advisable to do this the day before testing. The inspection, plus a review of the runway drawings, will permit selection of test locations prior to actual marking of the areas.

The distance test sections are located from the runway centerline is determined by inspection of the rubber buildup areas. The heaviest rubber accumulation will occur in the wheel path most common to the aircraft using the specific runway. Once the lateral distance from the centerline is established, the centerline of the 10-foot test sections is established to correspond to this location. For example, if the heaviest rubber buildup is located at a point 8 feet from the centerline, the centerline of all test sections selected will also be 8 feet from the runway centerline (except the edge test section). The longitudinal location of the rubber area test section is determined by the length of the buildup area. It is desirable, when possible, to center the heaviest buildup area at mid-point of the 2000-foot section.

Figure 2 shows in detail a 2000-foot test strip. The procedure for marking and laying out the test strips is given below. Generally, the selection and marking proceeds from one end of the runway toward the other end.

a. Locate one end of the test strip, measure the appropriate distance from the centerline, and mark the pavement surface with spray paint (a 3- to 4-inch circular mark). Measure 10 feet perpendicular to the runway centerline and mark the other corner of the test section.

b. Using the fifth wheel distance readout on the DBV, measure 2000 feet down the runway and mark the end of test strip in the same manner as before.

c. Locate and mark with spray paint the point at which the DBV will apply the brakes. This point is normally 300 feet from the test section end at which the water truck begins discharging water. (The 300-foot dimension is not and absolute value and can be varied to meet the individual runway conditions. Sufficient distance must remain within the test section to allow the DBV to stop.)

d. Once testing begins, traffic cones are used to mark the section being tested.

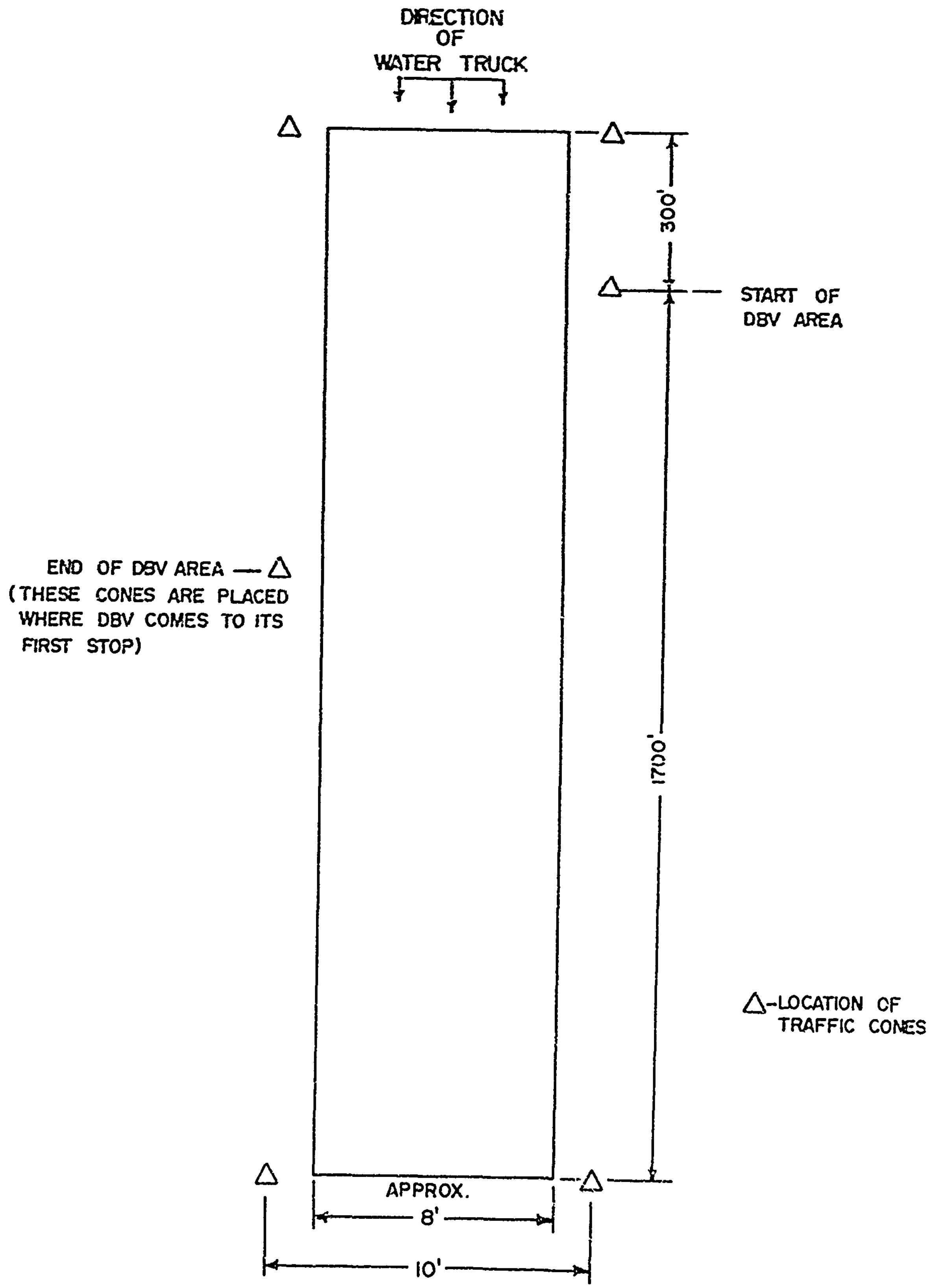


Figure 2. Typical Test Strip

SECTION III

WATER TRUCK CALIBRATION

1. GENERAL REQUIREMENTS FOR WATER TRUCK

The AFWL standard skid resistance test requires evaluation of the pavement under dry conditions and under artifically wet conditions simulating natural precipitation. Water tank trucks employed by flightline fire departments for foam application have been found quite adequate for use in wetting the pavement for the standard test.

To adequately wet the test area, the truck used must have a total capacity in excess of 3000 gallons. If two trucks are used, each should have at least 1500 gallons. The F-6 class tanker, which is available at most bases, works quite well. Extreme care should be taken to ensure that the water, either in storage on the truck or during spraying application, does not become contaminated by a foaming agent.

The spray must be pump fed and capable of holding a constant discharge pressure. The pump must operate as a separate unit, independent of the vehicle drive train, and sufficient instrumentation must be available to enable operation at a constant output. A valve should be located between pump and spray bar so that the pump can be stabilized at a static pressure before the wetting run is initiated.

The spray bar width should provide a traffic lane capable of accommodating the DBV and Mu-Meter test vehicles. The width of water path must be a minimum of 8 feet and a maximum of 12 feet. The actual spray width is determined by measuring the actual lay-down width immediately behind the water truck. Ideal height for spray nozzles is 12 inches above the pavement surface. This optimizes the water pattern and reduces loss due to wind. The spray bar should be centered on the axis of the truck so that the driver will not have difficulty in correctly positioning the wetted lane.

The tractor unit for the water truck must be equipped with a tachometer or a fifth wheel for precise speed determination, thus eliminating inaccuracies found in vehicle speedometers. Gearing/axle ratio must enable the truck to

maintain a constant low speed under changing load. (Test speed is normally between 5 and 10 mph.)

2. METHOD OF CALIBRATION

Exact determination of water quantity applied in the pavement is crucial to the accurate analysis of data when simulating natural precipitation. It has been determined that the application of 0.2 inch of water within a 15- to 20-minute period duplicates a heavy rainfall rate in excess of operational minimums. This creates a "worst possible" condition from which a time-dependent change in the coefficient of friction can be evaluated.

In the AFWL standard test, application of water is made in two passes of the truck, each applying 0.1 inch of water. For a truck equipped with an 8-foot spray width, 500 gallons must be evenly applied through 1000 feet to yield 0.1 inch application depth; with larger spray bars output increases in direct proportion to length of the spray bar. This relationship is shown graphically in figure 3. To ensure this output, pump speed and truck speed must remain constant. An iterative procedure for calibrating the water truck has been established and can be applied to water trucks equipped as previously described.

Basically the iterative procedure consists of dumping a full tank of water with the truck traveling at a constant speed and with constant pump output and measuring the pavement length and time required to dump the full tank. From these results, the speed required to put down a depth of 0.1 inch of water is calculated, and this calculated speed is refined by a dry run over a 2000-foot section. Suggested steps in calibration of the water truck follow.

a. Locate sufficient pavement area to allow uninterrupted operations for at least 2 hours. Preferably this area should allow for operating the water truck in a straight line only (3000 to 8000 feet long). A taxiway would be adequate for the calibration of the water truck. The actual length of pavement area required will depend upon the capacity of the water truck.

b. Select a setting of the tachometer (or fifth wheel indicator meter, usually reading in ft/min) for the initial calibration run. All runs must be made at constant speed with constant gear/axle setting. From previous experience, the best starting point in calibration is a second-gear, low-range axle with 1800 RPM tack setting (or 500 ft/min on the fifth wheel indicator meter). The setting selected should not vary by more than ± 25 RPM (or ± 10 ft/min, respectively, during any time that the truck is discharging water.

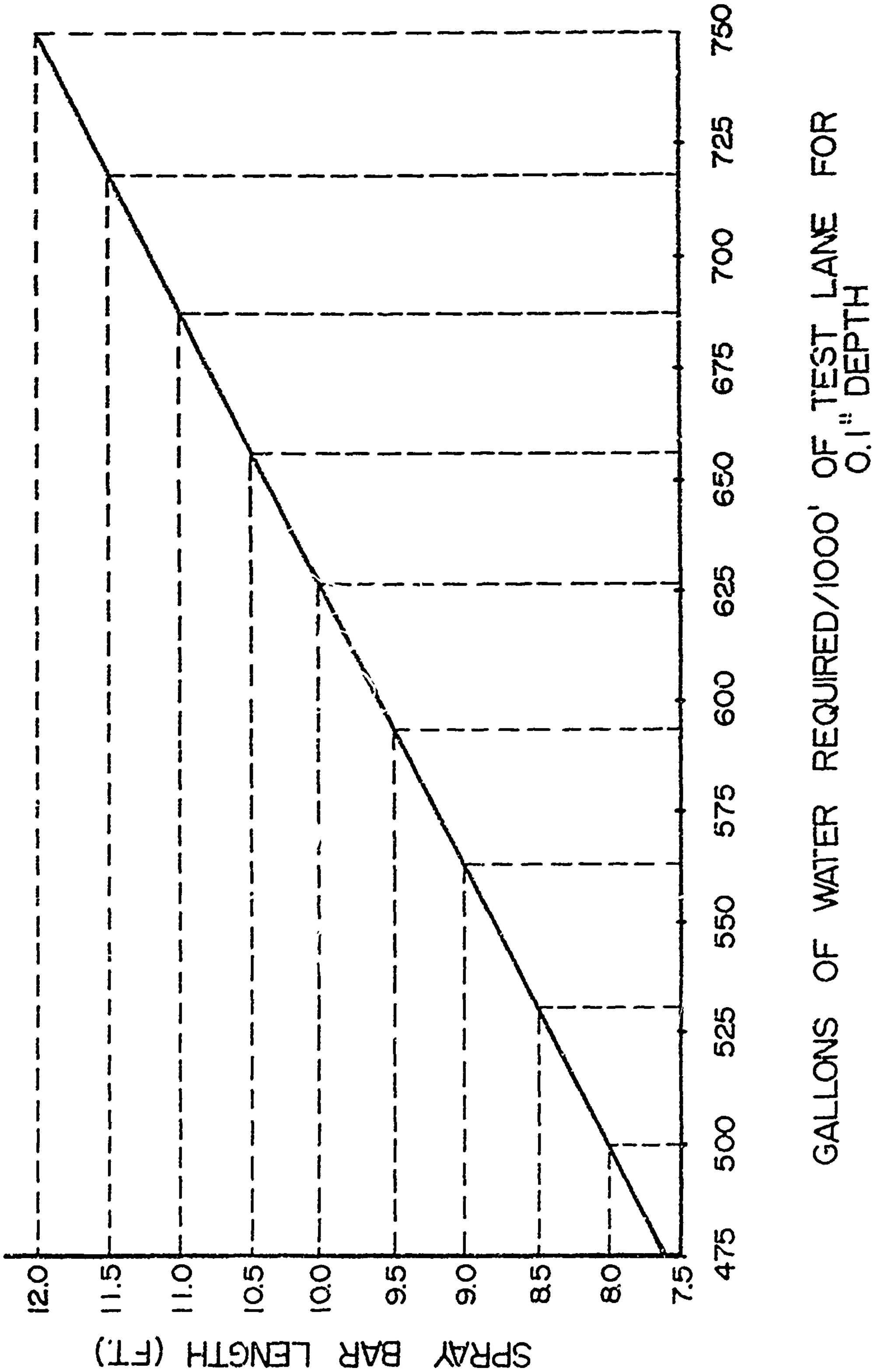


Figure 3. Water Discharge Corresponding to Varying Spray Bar Lengths

c. Instruct the pump operator to bring the pump to a maximum, stable, static pressure before water application. Note this pressure reading and before all future watering operations (calibration or actual test) establish the static pressure at the same setting. This will ensure a uniform, known water output which does not vary. Do not under any circumstances vary pump flow pressure once wetting has begun. Ensure that the water truck is filled to capacity at the start of calibration runs.

d. After static pump pressure has been established, start the truck moving at prescribed gear/axle/RPM setting, begin discharging water and mark the starting point for water discharge with a traffic cone.

e. If the section of pavement available is too short for a continuous discharge, establish a convenient cutoff point by setting up traffic cones. When the truck reaches this location, the pump operator closes the valve and stops the water discharge. The truck then turns around and establishes a constant speed before reentering the test section. The water is started again at the traffic cones marking the calibration section.

f. Record to the nearest second on a stopwatch the time required to empty the truck. In the case of e above, take special care to record only the actual wetting time.

g. Mark the location at which the truck runs out of water with a traffic cone. Using the DBV, measure and record the actual distance required to empty the truck.

h. Once distance and time for complete discharge under controlled conditions have been determined, apply the following relationship to find the approximate tachometer or fifth wheel setting for the required discharge/1000 feet of test strip:

$$RPM_d = \frac{W_a}{W_d} \times RPM_a$$

where

RPM_d = Tachometer setting in RPM (or fifth wheel meter reading) to yield desired discharge per 1000 feet

W_a = No. gallons of water discharged during calibration (equal to total capacity of the truck) divided by No. thousands of feet traversed

W_d = No. gallons of water desired per 1000 feet (read from figure 3)

RPM_a = Tachometer setting RPM (or fifth wheel meter reading) used during calibration run

i. Calculate the time required to place the necessary volume of water on a 2000-foot test strip using the following relationship

$$T_d = \frac{W_d}{W_a} \times T_a$$

where

T_d = Time required to apply desired water on 2000 feet

W_d = No. gallons of water desired per 1000 feet (read from figure 3)

W_a = No. gallons of water discharged divided by No. thousands of feet traversed

T_a = Measured time to traverse 2000 feet of test section in actual run = 2 (total time/distance in thousands of feet)

j. Lay out a 2000-foot section to be used in additional calibration runs. No water need be applied during these check runs. Using the tachometer (or fifth wheel setting) calculated above, make another calibration run over the 2000-foot strip and measure the exact time required to wet the strip. If this actual time differs from the calculated time above, compute again the tachometer (or fifth wheel) setting from this relationship

$$RPM_d = \frac{T_a}{T_d} \times RPM_a$$

k. If T_a and T_d are significantly different from each other, it may be necessary to repeat step j to achieve the desired accuracy in RPM (or fifth wheel) setting.

l. Example: A 4000-gallon truck discharged its total load through a 10-foot spray bar over a total distance of 9500 feet in 16.5 minutes. The truck was running at 1800 RPM in second gear/low axle range. At what RPM should the second calibration run be made and what is the expected time to wet a 2000-foot test strip with 0.1 inch of water?

$$RPM_d = \frac{W_a}{W_d} \times RPM_a$$

$$RPM_d = \frac{(4000/9.5)}{630} \times 1800$$

$$= 1200 \text{ RPM}$$

$$T_d = \frac{W_d}{W_a} \times T_a$$

$$= \frac{630}{(4000/9.5)} \times 2(16.5/9.5)$$

$$= 5.2 \text{ minutes}$$

If a 2000-foot test strip is traversed in 5 minutes while the tachometer is set at 1200 RPM, what is the final adjusted RPM for wetting the test section?

$$RPM_d = \frac{T_a}{T_d} \times RPM_a$$

$$= \frac{5.0}{5.2} \times 1200$$

$$= 1150 \text{ RPM}$$

3. WATER TRUCK CREW BRIEFING CHECK LIST

A check list for use in briefing the crew operating the water truck(s) is included in appendix II. The items included on this list should assist in preparing the water truck crew for competent and professional performance of their assigned tasks. The check list can be reproduced for use while gathering field data.

SECTION IV

CALIBRATION OF MU-METER

1. GENERAL

To ensure the Mu-Meter is functioning properly and correct friction values are being recorded, a standard calibration check is required at the beginning and at the end of each day of testing and after each change of tires. Additionally, if measured friction values should suddenly change unexpectedly, a calibration check should be made immediately to ensure the validity of data gathered. Each calibration check is preceded by a check of tire pressure, which must be kept exactly at 10 psi. As a further precaution that valid data is being gathered, tire pressure should be checked periodically during the day while tests are being run. It is suggested these checks be made after completion of a test section. Any deviation of tire pressure from 10 psi should be immediately corrected and noted on the data sheet.

2. STEPS IN STANDARD CLAIBRATION TEST

The following steps outline the correct procedure for calibration of the Mu-Meter. A minimum of two operators are required.

a. At the beginning of each day's testing the Mu-Meter should be warmed up before the calibration is checked or corrected. The warm-up should consist of operating the Mu-Meter in a test mode for 15 minutes.

b. Tire pressure must be set at precisely 10 psi.

c. Select a clean, dry area. Disconnect the Mu-Meter from the towing vehicle, and position the jockey wheel.

d. Place the standard checking board approximately 3 to 4 feet in front of the Mu-Meter with the measuring wheels in line with the abrasive surfaces of the checking board. Avoid walking on the abrasive surfaces while conducting the test.

e. The calibration board is cleaned by brushing the surface. The Mu-Meter tires are cleaned with a soft cloth to remove any small dirt particles, moisture, etc. The area between the board and Mu-Meter is also brushed clean. These cleaning procedures are very important to assure accurate calibration readings.

f. While one operator pulls the machine forward over the checking board, the second operator follows and oscillates the roll chart as the machine is moving, thus lessening the friction between the recorder stylus and the roll chart surface.

g. Check the stylus marking on the roll chart. Repeat this operation three additional times. The average of the last three readings should be equal to 0.77. If the stylus marking average differs from 0.77, the Mu-Meter must be adjusted as described in the following subsection.

3. ADJUSTMENT OF THE MU-METER

If it is found that friction readings are low, the adjustment turnbuckle should be shortened to increase the toed-out angle of the tires, alternatively, if the readings are high, the turnbuckle should be lengthened to decrease the toed-out angle. The correct amount of adjustment can be arrived at in both case only by trial and error. To adjust the wheel toed-out angle, proceed as follows:

a. Remove the lockwire from the wheel adjustment turnbuckle.

b. Slacken the turnbuckle locknuts one-half turn (one right-hand and the other left-hand thread).

c. Turn the tension rod by no more than a half-turn to shorten or lengthen the turnbuckle as appropriate to increase or decrease the toed-out angle. Temporarily tighten the locknuts.

d. Perform the calibration test outlined in section IV.2, and shorten or lengthen the tension rod progressively by small increments after each run until the readings are restored precisely to 0.77.

e. When an average reading of 0.77 is achieved, tighten the turnbuckle locknuts and lock the turnbuckle with stainless steel wire.

SECTION V

SKID DATA COLLECTION

1. GENERAL

As part of the standard test, a number of items used in the analysis of data must be recorded for each test section. These items are listed below (with examples). The format for recording each item is shown in figures 4 and 5. Note that figure 4 also contains spaces for the watering record (spaces numbered 47 through 72). The times of water applications are recorded by the technician riding with the water truck, as explained in section V.4; the form in figure 4 must therefore be in the technician's hands when the watering procedure is started. The remaining data shown below can be recorded at the convenience of the test conductor.

Base (6 letter abbreviation)	LYNNTH
Test strip designation	A
Runway identification (small number first)	06/24
Test section description (rubber, center, edge, etc.)	RUBBER
Temperature in °F	60
Dew point in °F	48
Wind direction in compass degrees	270
Wind velocity in knots	20
Gusty wind velocity in knots	25
Watering record (see section V.4)	
Type pavement (PCC, ACC, etc.)	PCC
Longitudinal slope in percent (From record drawings. Slope is positive if the elevation is increasing to the north or east.)	-1.5
Tranverse slope in percent (This is the average slope of the test section as recorded by the slope measuring device.)	-1.2

RECORDER ____

GENERAL INFORMATION

BASE ABBREVIATION								TEST STRIP							RUNWAY IDENT.					TEST STRIP DESCRIPTION						
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
																	/									

EXAMPLE

L	K	N	H	T	H				A						Ø	6	/	2	4	R	U	B	B	E	R	

WEATHER INFORMATION

TEMP. °F						DEW PT. °F			WIND DIR.				WIND VEL.			GUST. WIND VEL.	
28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45

EXAMPLE

	6	Ø				4	8		2	7	Ø		2	Ø		2	5

WATER RECORD

	WATER 'IN', TOT. STRIP								WATER 'IN', DBV STRIP								WATER 'OUT', TOT. STRIP						
	HR.			MIN.			SEC			HR.			MIN.			SEC.		HR.			MIN.			SEC.
46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72

EXAMPLE

	1	4		4	1		Ø	5		1	4		4	1		4	8		1	4		4	5		Ø	1

ZERO WATER TIME							
HR.			MIN.			SEC.	

NOTES: O = LETTER O
Ø = ZERO
ALL DATA IS RIGHT JUSTIFIED. THIS MEANS ANY BLANK SPACES APPEAR AT THE LEFT OF THE FIELD.

Figure 4. General Information, Weather, and Water Record

BASE ______________________ RUNWAY ______________

RECORDER ____________________ DATE ______________

TEST SECTION ____________________

TYPE PAVEMENT	LONG. SLOPE	TRANSVERSE SLOPE	SECTION LENGTH	DIST FROM ℄	DIST TO START OF DBV SECT	WATER DEPTH
3 4 5	7 8 9 10	12 13 14 15	17 18 19 20	23 24 25	28 29 30	36 37 38 39 40

EXAMPLE

TYPE PAVEMENT	LONG. SLOPE	TRANSVERSE SLOPE	SECTION LENGTH	DIST FROM ℄	DIST TO START OF DBV SECT	WATER DEPTH
PCC	-1.5	-1.2	2ØØØ	5	3ØØ	.ØØ8

NO DRY MU RUNS	NO DRY DBV RUNS	NO TARE RUNS	NO WET MU RUNS	NO WET DBV RUNS	DATE (S) OF TEST
44 45	47 48	50 51	53 54	56 57	61 62 63 64 65 66 67 68 69 70 71 72

EXAMPLE

NO DRY MU RUNS	NO DRY DBV RUNS	NO TARE RUNS	NO WET MU RUNS	NO WET DBV RUNS	DATE (S) OF TEST
2	2		1Ø	8	11-12 NOV 72

NOTES: O = LETTER O
Ø = ZERO
ALL DATA IS RIGHT JUSTIFIED. THIS MEANS ANY BLANK SPACES ARE AT LEFT OF FIELD

Figure 5. General Information

Length of test section in feet	2000
Distance from centerline in feet	5
Distance to start of DBV section from end of total section	300
Water depth in inches (Leave these spaces blank. This value was developed only for research at AFWL.)	.008
Number of dry Mu-Meter runs in section	2
Number of dry DBV runs in section	2
Number of tare runs in section (Leave these spaces blank. This value was developed only for research at AFWL.)	10
Number of wet DBV runs in section	8
Date(s) of test	11-12 Nov 72

2. SEQUENCE OF EVENTS

The following outline contains an overview of events which must take place during the testing program.

a. Before testing (afternoon before test day)

(1) Briefing of base personnel.

(2) Arrange with motor pool for tire change and high-test gasoline for the DBV.

(3) Check storage area provided for the equipment and arrange to pick up equipment about 2 hours before testing.

(4) Check on availability of a taxiway that could be used for water truck calibration before testing period.

(5) Test conductor inspects the runway and selects general location for test sections.

(6) Test conductor conducts a team briefing to go over testing sequence, test section location, order that test sections will be tested, and team assignments.

b. Two hours before runway closure

(1) Complete vehicle check lists.

(2) Brief fire truck crew.

(3) Warm up the Mu-Meter by driving it with the wheels toed out for about 15 minutes.

(4) Calibrate Mu-Meter after warmup.

(5) Arrange to have BAK-9/12 removed from both ends of the runway as soon as runway is closed.

(6) Final check of test sequence with crew.

c. Dry Test (2 hours)

(1) Test conductor selects and marks test sections (DBV provides measurements).

(2) Mu-Meter personnel make the slope measurements at predetermined intervals.

(3) Water truck calibration (DBV provides periodic distance measurements). Items a to c occur simultaneously. The water truck may have been calibrated earlier and if so this period should be used to check out the driver and pump operator over a 2000-foot calibration section.

(4) Dry stops--DBV. After each test section has been marked the DBV can make the dry stops on that section.

(5) Dry test--Mu-Meter. Once slope measurements are complete the Mu-Meter may begin making dry test runs.

(6) It is desirable to make full-length runway Mu-Meter recordings if time is available. The Mu-Meter tape should be marked using the runway markers as distance indicators. Figure 6 indicates locations for the full length Mu-Meter runs.

It must be noted that as soon as the DBV completes the dry test it should be released to go to the motor pool for the tire change.

d. Wet Test Period

(1) Check out fire truck crew.

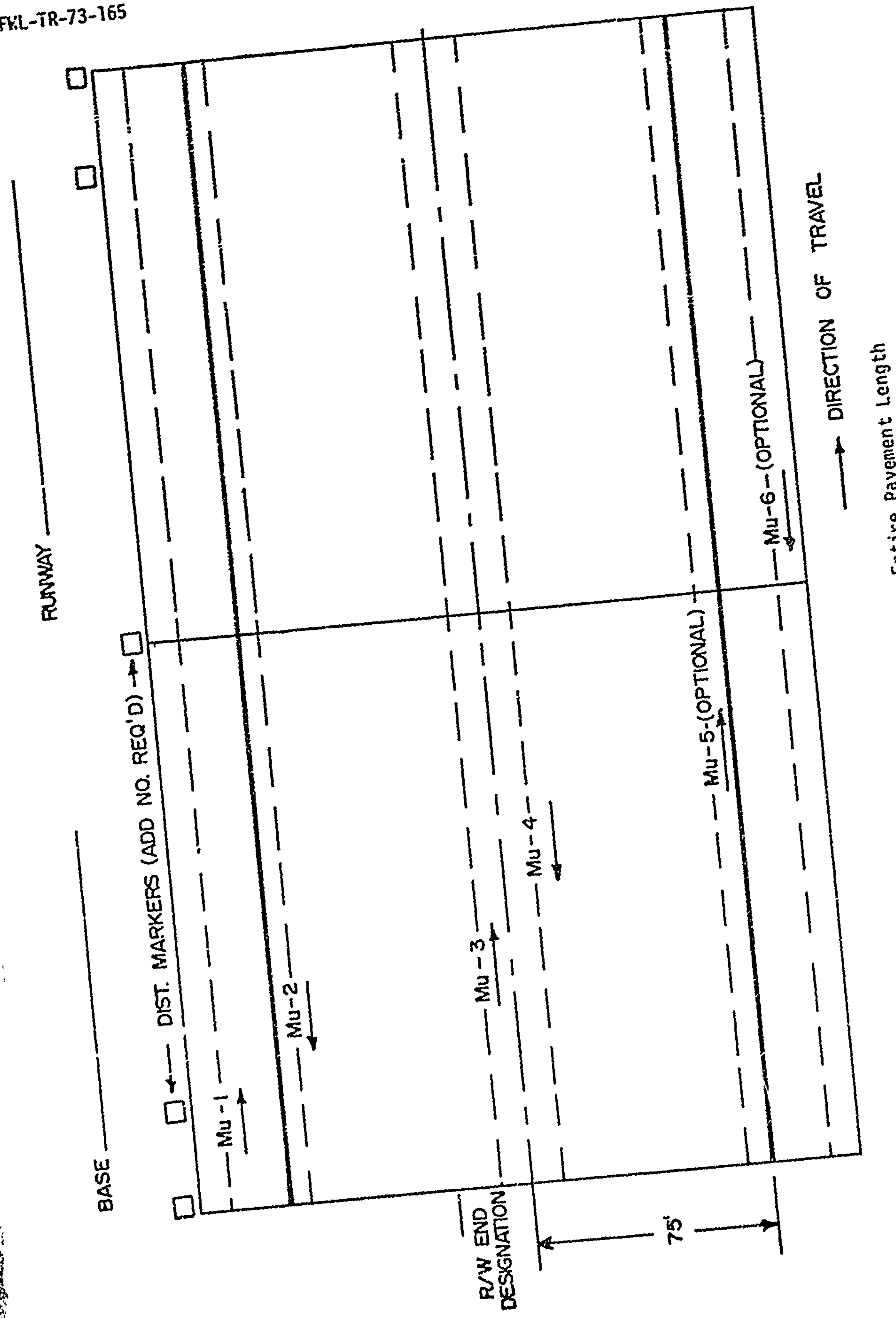


Figure 6. Mu-Meter, Dry Runs on Entire Pavement Length

(2) Test conductor places traffic cones in test section and positions vehicles.

(3) Test conductor starts water truck.

(4) When the water truck is finished it exits the runway and refills.

(5) The DBV is started by the test conductor when the water truck reaches a predetermined location.

(6) The test conductor starts the Mu-Meter when the water truck is at the correct location.

(7) The DBV makes the return run when the Mu-Meter clears the test section. The Mu-Meter then makes its return run when the DBV clears. This is continued until 6 runs have been made.

(8) After the third run the test conductor begins setting up the next test section.

(9) Mu-Meter makes a 20-minute run.

(10) Both vehicles make test runs at 30 minutes.

(11) Test conductor then starts the water truck on the wetting passes of the next test section.

(12) Vehicles complete check list and get into position and repeat above sequence.

(13) After run number 6 the Mu-Meter returns to the previous test section and makes two additional runs. This provides 40 to 50 minute data points.

3. DRY RUNWAY TESTS

Both the DBV and the Mu-Meter are used in testing dry surfaces. Data sheets have been prepared for recording the data in punch card format as it is gathered by the technicians riding in the DBV and the Mu-Meter towing vehicle. Figure 7 shows the data sheets for use with the Mu-Meter and figure 8 shows the data sheets for use with the DBV. The data gathered for each Mu-Meter run include (with examples shown):

BASE ____________________ RUNWAY ____________________

RECORDER ____________________ DATE ____________________

TEST SECTION ____________________

FIRST RUN

RUN DESIGNATION						TIME						C DIAL					B DIAL		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20

SECOND RUN

RUN DESIGNATION						TIME						C DIAL					B DIAL		
21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40

THIRD RUN

RUN DESIGNATION						TIME						C DIAL					B DIAL		
41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60

FOURTH RUN

RUN DESIGNATION						TIME						C DIAL					B DIAL		
61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80

NOTES: O = LETTER O

Ø = ZERO

ALL DATA IS RIGHT JUSTIFIED. THIS MEANS ANY BLANK SPACES ARE AT LEFT OF FIELD.

EXAMPLE

RUN DESIGNATION						TIME						C DIAL					B DIAL		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	A	Ø	I	D	W	1	3	5	6				3	3			1	Ø	2

Figure 7. Mu-Meter Runs on Dry Pavement

BASE ____________________ RUNWAY ____________________

RECORDER ____________________ DATE ____________________

TEST SECTION ____________________

FIRST RUN

RUN DESIGNATION						TIME							VEL mph			STOP DIST			
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20

SECOND RUN

RUN DESIGNATION						TIME							VEL mph			STOP DIST			
21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40

THIRD RUN

RUN DESIGNATION						TIME							VEL. mph			STOP DIST			
41	42	43	44	45	45	47	48	49	50	51	52	53	54	55	56	57	58	59	60

FOURTH RUN

RUN DESIGNATION						TIME							VEL mph			STOP DIST			
61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80

NOTES. O= LETTER O

Ø= ZERO

ALL DATA IS RIGHT JUSTIFIED. THIS MEANS ANY BLANK SPACES ARE AT LEFT OF FIELD.

EXAMPLE

RUN DESIGNATION						TIME							VEL mph			STOP DIST.			
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	A	Ø	1	D	E	1	3	5	8				6	1			3	5	5

Figure 8. DBV Runs on Dry Pavement

Designation of Run A01DW

A is the test strip designation

01 means it is the first run made in that strip

D means the pavement was dry

W means the vehicle was traveling in westerly direction

Time Entering Strip (24-hour clock) 1356

"C" Dial Reading (from instrumentation) 33

"B" Dial Reading (from instrumentation) 102

(The "C" dial reading divided by "B" dial reading is the integrated coefficient of friction value over the area traversed.)

The data gathered from each DBV run include (with examples shown):

Designation of Run A01DE

A is the test strip designation

01 means it is the first run made in that strip

D means the pavement was dry

E means the vehicle was traveling in an easterly direction

Time Entering Strip (24-hour clock) 1358

Initial Velocity in mph 61

Stopping Distance in Feet 0355

A minimum of two readings (one in each direction) should be made in each test strip while the pavement is dry; up to four readings can be processed in the computer program.

4. APPLICATION OF WATER

As soon as dry testing has been completed and vehicles serviced, the water truck(s), DBV, and Mu-Meter should be placed in that order at the end of the test strip, in preparation for the wet testing sequence. The suggested order of events for application of water to each test strip is as follows:

a. Water truck makes first wetting pass releasing 0.1 inch of water as determined in the calibration run. If only one water truck is being used, driver returns the truck to the starting point as rapidly as possible.

b. Water truck makes second wetting pass, releasing another 0.1 inch of water. If two trucks are being used in the wetting operation, the second truck starts its wetting pass as soon as the first truck has wetted approximately 1000 feet of the test strip. The time the second water truck enters the test section, the time it enters the DBV portion of the test section, and the time it exits the total section are recorded in spaces 47 through 72 of the form shown in figure 4, using the format shown below.

Water Truck "In" Time, Total Section (2nd pass) (in hours, minutes, seconds on 24-hour clock)	14	41	05
Water Truck "In" Time, DBV Section (2nd pass)	14	41	42
Water Truck "Out" Time, Total Section (2nd pass)	14	45	01

As stated earlier, the data sheet shown in figure 4 should be in the hands of the technician recorder riding with the water truck, for recording of the times shown.

c. Technican recorder computes the zero water time (average of the Water "In" Total Strip and Water "Out" Total Strip), and records it on the forms shown in figure 4. This time is relayed by radio to the test conductor for controlling run times of the DBV and Mu-Meter.

d. The water trucks turn sharply out of the way at the end of the test strip, tanks are refilled to capacity, and the trucks return to the edge of the runway. The test conductor directs the water truck into position at the appropriate time.

5. WET RUNWAY TESTS

As soon as the second water pass is underway and the water truck is a sufficient distance down the test strip to avoid a possible rear-end collision, the DBV should begin its first run. The following distances can be used as a guide for determining what a sufficient distance down the test strip is, based on the DBV section placed 300 feet from the end.

Type of Test Strip	Distance, Feet
Rubber coated touchdown area	1400
Runway center	1100
Runway edge	1000

The following is the suggested sequence of events for gathering data on the wetted pavement:

a. DBV makes its first run, applying brakes at the beginning of the DBV section. Traffic cone is placed at the point of stop by the test conductor. The technican recorder in the DBV records the following data in the format of figure 9 (with examples shown below):

Designation of Run

AA is the test strip designation

01 means it is the first DBV run made in that strip

W means the pavement was wet

S means the vehicle was traveling in a southerly direction

"Lock" Time of DBV (in hours, minutes, seconds, on 24-hour clock)	10 55 21
"Stop" Time of DBV	10 55 42
Initial Velocity in mph	60
Stopping Distance in Feet	1116
Stopping Distance Adjusted to 60 mph (= stopping distance multiplied by conversion factor shown in table I)	1116

As soon as the DBV has come to a complete stop and the point has been marked with a cone (on the first run), the driver of the DBV turns sharply out of the test strip and accelerates around the water truck and out of the way of the Mu-Meter.

b. The Mu-Meter follows as soon as the water truck is approximately 1800 feet down the test strip (200 feet from completion of the second wetting pass). Instructions to start are given by the test conductor. "Blips" on the Mu-Meter tape are used to mark the ends of the test strip and both ends of the DBV section of the test strip as the equipment passes those points. Two "blips" are used to mark each end of the test strip and a single "blip" is used to mark each end of the DBV section. The technician recorder in the Mu-Meter towing vehicle records the following information in the format of figure 10 (with examples following).

AIRFIELD ____________________ RUNWAY ____________________

RECORDER ____________________ DATE ____________________

RUN DESIGNATION	LOCK TIME h	LOCK TIME m	LOCK TIME s	STOP TIME h	STOP TIME m	STOP TIME s	TEST SPEED mph	STOP DIST FT.	STOP DIST ADJ. TO 60 MPH
1 2 3 4 5 6	8 9	11 12	14 15	18 19	21 22	24 25	28 29 30	32 33 34 35	

EXAMPLES

RUN DESIGNATION	LOCK TIME h	LOCK TIME m	LOCK TIME s	STOP TIME h	STOP TIME m	STOP TIME s	TEST SPEED mph	STOP DIST FT.	STOP DIST ADJ. TO 60 MPH
A A Ø 1 W S	1 Ø	5 5	2 1	1 Ø	5 5	4 2	6 Ø	1 1 1 6	1 1 1 6
B 1 Ø W N	1 Ø	5 9	Ø 6	1 Ø	5 9	2 3	6 1	3 5 2	3 4 Ø

NOTES: ZERO—Ø, LETTER O—O. ALL DATA IS RIGHT-JUSTIFIED.
THIS MEANS ANY BLANK SPACES ARE AT LEFT OF FIELD

Figure 9. DBV Stopping Time and Distance on Wet Pavement

Table I

CONVERSION FACTORS FOR STOPPING DISTANCES

To Convert a Stopping Distance (SD) at this MPH	Multiply the SD by this Factor
55	1.190
56	1.148
57	1.108
58	1.070
59	1.034
60	1.000
61	0.967
62	0.936
63	0.907
64	0.879
65	0.852

AIRFIELD ____________________ RUNWAY ____________________

RECORDER ____________________ DATE ____________________

RUN DESIGNATION							TIME IN h			TIME IN m			TIME IN s				TIME OUT h			TIME OUT m			TIME OUT s				"C" DIAL					"B" DIAL			INTEGRATED COEF.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	

EXAMPLES

RUN DESIGNATION	TIME IN h	TIME IN m	TIME IN s	TIME OUT h	TIME OUT m	TIME OUT s	"C" DIAL	"B" DIAL	INTEGRATED COEF.
AAØ1WN	1Ø	13	19	1Ø	13	54	32	1Ø3	31
OOØ1WS	9	15	23	9	16	Ø3	63	99	64
B1ØWS	1Ø	54	26	1Ø	54	54	61	96	64

NOTES: ZERO = Ø, LETTER = O. ALL DATA IS RIGHT-JUSTIFIED.
THIS MEANS ANY BLANK SPACES ARE AT LEFT OF FIELD.

Figure 10. Mu-Meter Measurements of Pavement Friction on Wet Pavement

Designation of Run

AA is the test strip designation

01 means it is the first Mu-Meter run made in that strip

W means the pavement was wet

N means the vehicle was traveling in a northerly direction

Mu-Meter "In" Time	10	13	19
Mu-Meter "Out" Time	10	13	54
"C" Dial Reading (from instrumentation)		32	
"B" Dial Reading (from instrumentation)		103	
Integrated Coefficient (=C/B. This is a calculation to check the accuracy of data being gathered.)		31	

c. As soon as the Mu-Meter exits the test strip, the DBV starts its run in the opposite direction. Data are recorded as before, using the next line of the form shown in figure 9.

d. When the DBV has skidded to a stop and has cleared, the driver notifies the test conductor by radio that he is clear; the Mu-Meter follows down the test strip. Data are recorded as before, using the next line of the form shown in figure 10.

e. Repeating the procedure in 3 and 4 above, four additional runs of the DBV and Mu-Meter are made (two additional "round-trips" on the test strip).

f. At approximately 20 minutes and 30 minutes after "zero water time" (as defined in section V.4), an additional run of the Mu-Meter is made. If the pavement is not dry, the Mu-Meter run 30 minutes after "zero water time" is preceded by a run of the DBV. If the pavement is dry to the point that it would excessively wear the locked wheel tires on the DBV, this run is omitted from the standard test. On runway surfaces where the 30-minute DBV run is omitted, both vehicles make the 20-minute run on the next test section.

6. EXTRACTION OF DATA FROM MU-METER TAPES

While Mu-Meter runs on the wetted surface are being made, a continuous tape record of the coefficient of friction is being recorded. At the beginning of each Mu-Meter run, the tape is manually marked with the same run designation used

in figure 10. As stated earlier, "blips" are used to show the boundaries of the test section--two "blips" to mark the beginning and the end of each test strip and a single "blip" to mark the beginning and the end of the DBV section.

When the Mu-Meter runs for a test section have been completed, the data shown in figure 11 must be extracted from the tapes and recorded where designated. These data consist of the following (with examples):

Minimum Mu over Total Test Section	30
Maximum Mu Over Total Test Section	60
Average Mu Over Total Test Section (This is an "eyeballed" value.)	50 *
Minimum Mu Over DBV Area	35
Maximum Mu Over DBV Area	40
Average Mu Over DBV Area (This is an "eyeballed" value.)	45
Run Designation (same as in figure 10)	AA01WN

Note that the columns of the form in figure 11 are numbered beginning with 36. This form is actually a continuation of figure 10 so that the two of them must be placed together (side by side) when data are keypunched. The run designations of figure 11 must therefore follow the same order as those of figure 10, when the data in figure 11 are extracted from the Mu-Meter tapes. The actual extraction of the data from the tapes can, of course, be accomplished at any time after the testing of a section is completed and at the convenience of the test conductor.

---

* This value is used to check the integrated value obtained. If a large variance is noted, then this section of the Mu-Meter tape must be planimetered to obtain the average Mu value.

AIRFIELD ______________________ RUNWAY ________________________

RECORDER ______________________ DATE ________________________

	MIN. MU, TOTAL SECTION					MAX. MU, TOTAL SECTION					AVG. MU, TOTAL SECTION					MIN. MU, DBV AREA					MAX. MU, DBV AREA					AVG. MU, DBV AREA					RUN DESIGNATION					
36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72

EXAMPLES

			3	Ø				6	Ø				5	Ø				3	5				5	Ø				4	5		A	A	Ø	I	W	N
			3	1				6	2				4	9				4	Ø				5	5				5	Ø		O	O	Ø	I	W	S
			2	5				5	5				4	5				3	Ø				4	5				4	Ø			B	I	Ø	W	S

NOTES: ZERO = Ø, LETTER O = O ALL DATA IS RIGHT-JUSTIFIED.
THIS MEANS ANY BLANK SPACES ARE AT LEFT OF FIELD.

Figure 11. Mu-Meter Tape Data

SECTION VI

SLOPE MEASUREMENT

1. GENERAL

The relative slipperiness of a pavement and, consequently, its tendency to encourage hydroplaning are closely related to the depth of the water held on its surface. Since the amount and depth of water held are directly related to the slope of the surface, a complete evaluation of surface slope is conducted as part of the standard AFWL skid resistance test. Longitudinal slope of each test section (being of lesser importance in draining water away than lateral slope) is taken from any record drawings which may be available, and is recorded with the "general information" data shown in figure 5.

Lateral slope measurement is done with a specially constructed straightedge equipped with leveling bubbles. Measurements are taken on both sides of the runway centerline at 500- or 1000-foot intervals throughout the length of the runway. Normal procedure is to measure the slope at a starting point at the end, and then to choose subsequent points to coincide with runway distance markers and/or points halfway between markers. The fifth wheel distance readout on the DBV is used to determine the location of points, and each point is marked with spray paint, prior to slope measurement. Two slope measurements are made on each side of the centerline at each designated point. If the pavement has been loaded primarily by one aircraft type (e.g., B-52 traffic at a SAC base), slope measurements must be made to include the wheel path areas. This distance has previously been determined by the examination of the rubber areas. A general procedure is as follows:

a. Make one slope measurement at each point with the slope measuring device perpendicular to and touching the runway centertline.

b. Make a second slope measurement with the device located a distance equal to the length of the straightedge from the centerline.

c. Repeat the above procedure at each point for the area on the opposite side of the centerline.

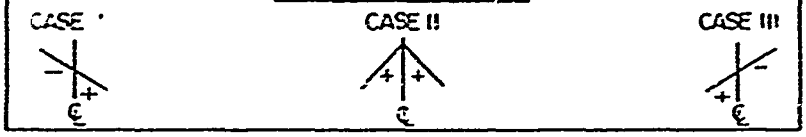
d. Record all measured slopes (in percent) on the form shown in figure 12, using the sign convention indicated. Note that the form is designed so that measurements can begin at either end of the runway, by designating the starting end in spaces labeled RUNWAY END. Each line contains slope measurements made on both sides of the centerline at a single point; use as many lines as are necessary to record the lateral slope of the entire runway.

2. COMPUTATION OF AVERAGE LATERAL SLOPE

The vertical "boxes" at each side of the form in figure 12 are provided for ease in marking the location of test st ips. Two examples are provided showing the locations of test strips B and F. (The example provided indicates that test strip B lies between runway distance markers 1 and 3.) If the location of any test strip is on the left of the runway centerline, its location is marked in the vertical "box" on the left of the form, and similarly for test strips on the right of the runway centerline. Once the location of a test strip is marked, the average lateral slope of that strip can be computed by averaging all included slope measurements on the same side of the centerline. This average number must then be entered as the transverse slope of that part cular test section on the form in figure 5.

RECORDER ____________________ RUNWAY ____________________

SIGN CONVENTION



1	2	3	4	5	6	BASE ABBREV.

7	8	9	10	11	12	13	14	15	RUNWAY END (NORTH, ETC)

16	17	18	19	20	NO. LINES USED BELOW

EXAMPLE

SECTION & LIMITS

STATION NO. (R/W DIST MARKER) 1–6	% SLOPE 8–11	% SLOPE 13–16	% SLOPE 18–21	% SLOPE 23–26
Ø+ØØØ				
Ø+5ØØ				
1+ØØØ				
1+5ØØ				
2+ØØØ				
2+5ØØ				
3+ØØØ				
3+5ØØ				
4+ØØØ				
4+5ØØ				
5+ØØØ				
5+5ØØ				
6+ØØØ				
6+5ØØ				
7+ØØØ				
7+5ØØ				
8+ØØØ				
8+5ØØ				
9+ØØØ				
9+5ØØ				
1Ø+ØØØ				
1Ø+5ØØ				
11+ØØØ				
11+5ØØ				
12+ØØØ				
12+5ØØ				
13+ØØØ				
13+5ØØ				
14+ØØØ				
14+5ØØ				
15+ØØØ				
15+5ØØ				

B

F

SECTION & LIMITS

℄

RUNWAY END (SOUTH, ETC)

NOTES:

Ø – ZERO
O – LETTER O

EXAMPLE: Ø+ØØØ +1.5 +1.4 +1.3 +1.2

Figure 12. Pavement Cross-Slope Measurements

SECTION VII

USE OF THE COMPUTER ANALYSIS PACKAGE

1. GENERAL

The computer analysis package developed by AFWL for analysis of skid resistance data is written for use on the CDC 6600 computer system. The output from the analysis package includes a number of plotted curves; the computer system used must, therefore, contain plot capability.

The analysis package was developed to eliminate the drudgery of manual calculations and plotting of data points, as well as to increase the accuracy of such work. As an added feature, the analysis package produces a written report which, with only a small amount of individualizing for each airfield tested, can serve as the written record of evaluation work done.

2. STEPS IN USE OF THE ANALYSIS PACKAGE

A separate AFWL publication with detailed instructions on use of the analysis package is being prepared and will be released in the near future. The instructions contained here are intended as supplementary instructions to allow interim use of the analysis package pending release of the other publication.

Appendix I contains a sample report produced by the analysis package. Those portions of the report which have been individually prepared are obvious; these sections are held to the minimum number consistent with producing an individualized report.

As stated earlier, special forms have been prepared for recording all data gathered and are shown in appendix II. These forms, when properly used, are designed such that minimum effort is required in preparing input information for the computer analysis package. In addition to the data recording forms already discussed and shown in previous sections of this report, a group of header cards are required to provide essential information to the computer analysis package. Forms for recording information for these header cards are shown in figures 13, 14, and 15 and are provided in appendix II. The information to be recorded on header card 1 and header card group 2 follows (with examples).

BASE NAME																				NO. SECTIONS TESTED					
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26

EXAMPLE

				K	I	R	T	L	A	N	D		A	F	B								1	Ø	

AGENCY PERFORMING TEST																																	
27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60

EXAMPLE

A	I	R		F	O	R	C	E		C	I	V	I	L		E	N	G	I	N	E	E	R	I	N	G		C	E	N	T	E	R

NO. CARDS USED TO LIST REASONS FOR TEST (MAX = 4)									
61	62	63	64	65	66	67	68	69	70

EXAMPLE

									1

NOTES: O = LETTER O

Ø = ZERO

"BASE NAME" AND "AGENCY PERFORMING TEST" SHOULD BE CENTERED IN THE SPACE PROVIDED.

FIELD FOR "NO. SECTIONS TESTED" IS RIGHT JUSTIFIED. THIS MEANS ANY BLANK SPACES APPEAR AT THE LEFT OF THE FIELD.

Figure 13. Header Card No. 1

USE ALL OR ANY PORTION OF THE 4 CARDS BELOW TO RECORD REASONS FOR THE TEST (OTHER THAN EVALUATION OF SKID RESISTANCE) NUMBERED BEGINNING WITH (2).

CARD 1

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40

41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80

CARD 2

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40

41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80

CARD 3

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40

41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80

CARD 4

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40

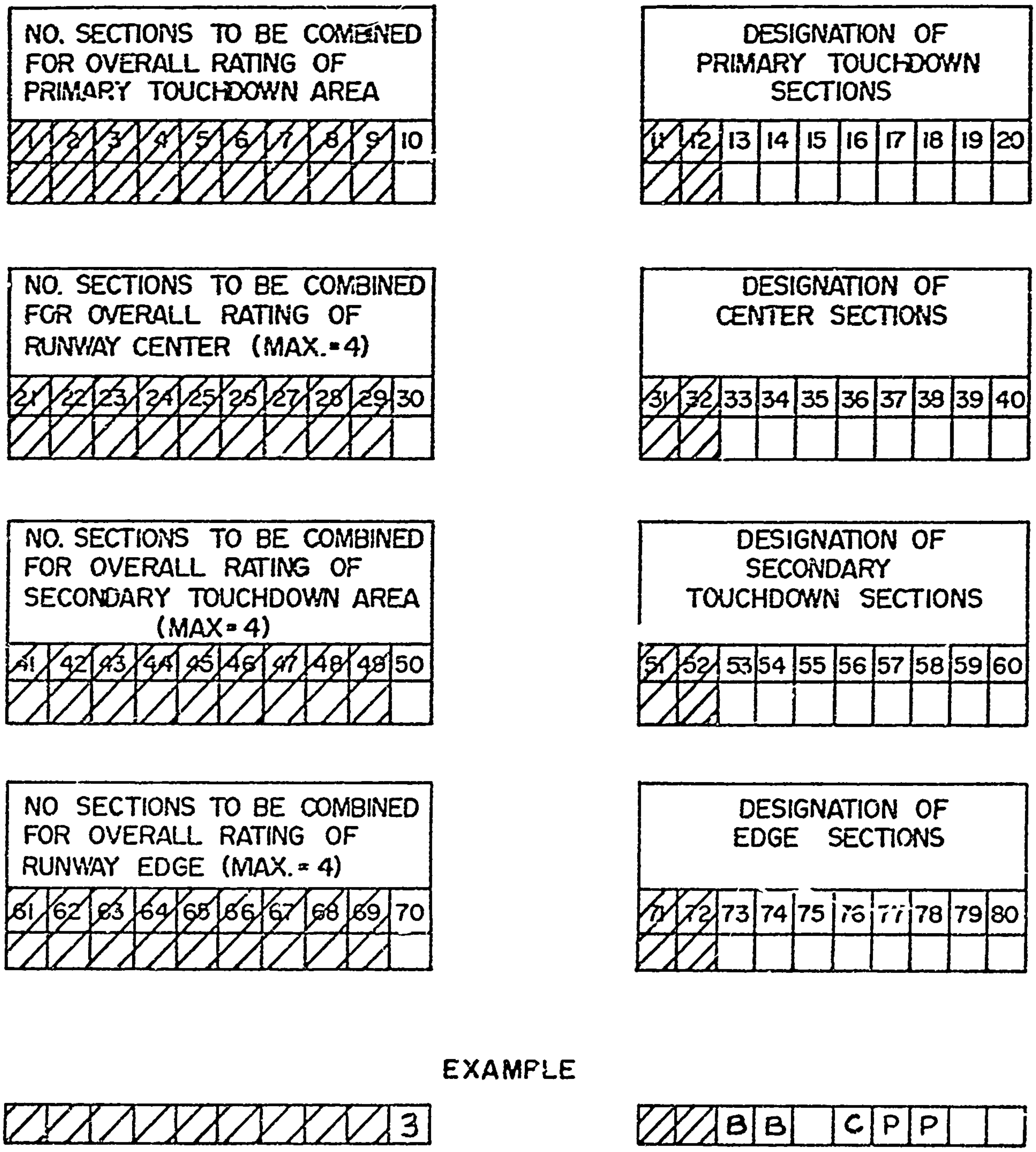
41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80

EXAMPLE

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
(	2	)	T	O		R	E	C	O	M	M	E	N	D		C	O	R	R	E	C	T	I	V	E		A	C	T	I	O	N	,		I	F		I	N

41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
D	I	C	A	T	E	D		(	3	)	T	O		C	H	E	C	K		R	C	R		V	A	L	U	E	S		I	N		U	S	E	.		

Figure 14. Header Card Group No. 2



NOTES: O = LETTER
Ø = ZERO
WHEN DESIGNATING TEST SECTIONS TO BE COMBINED, SKIP A SPACE BEFORE AND AFTER THE LETTER DESIGNATION, UNLESS THE SECTION IS DESIGNATED BY A DOUBLE LETTER, SUCH AS "BB." SEE EXAMPLE ABOVE.

Figure 15. Header Card No. 3

Base Name	Kirtland AFB
Number of Sections Tested	10
Agency Performing Test	Air Force Civil Engineering Center
Number of Cards used to List	2
Reasons for Test (Max. = 4) (Other than evaluation of skid resistance) numbered beginning with (2)	(2) To recommend corrective action, if indicated (3) To check RCR values currently in use.

Header card number 3 (figure 15) is provided to give the user some flexibility on how the results are portrayed in the report. Information on this header card is used to control the data displayed in the top of table I of the report (see appendix I). This card is used to determine which test section data are combined to give overall ratings for the primary touchdown area, the central protion of the runway, the secondary touchdown area, and the runway edge. Combinations of data from test sections mus be carefully done to ensure representative values appear in the data summar . This header card give the user the flexibility to exclude atypical sections from the summary, while still portraying all information gathered in the report appendix.

Specific information to be recorded on header card number 3 is listed below, with examples shown:

Number of Sections to be Combined for Overall Rating of Primary Touchdown Area (Max. = 4)	2
Designation of Primary Touchdown Sections to be Combined	A B
Number of Sections to be Combined for Overall Rating of Runway Center (Max. = 4)	2
Designation of Center Sections to be Combined	C D
Number of Sections to be Combined for Overall Rating of Secondary Touchdown Area (Max. = 4)	2
Designation of Secondary Touchdown Sections to be Combined	E F
Number of Edge Sections to be Combined for Overall Rating of Runway Edge (Max = 4)	1
Designation of Edge Sections to be Combined	G

Complete input data for the computer program should be keypunched on cards. Following is the correct order of the cards for proper operation of the analysis package:

a. Header card number 1

b. Header card group number 2 (may be more than 1 card)

c. Header card number 3

d. General information, weather, and water record for first section

e. General information for first section

f. Mu-Meter runs on dry pavement for first section

g. DBV runs on dry pavement for first section

h. Mu-Meter measurements of pavement friction on wet pavement and data extracted from Mu-Meter tapes for first section. (These two sheets, placed side by side for keypunching, provide a group of cards.)

i. DBV stopping time and distance on wet pavement for first section (group of cards).

j. Repeat of d through i for second section, third section, fourth section, etc.

k. Pavement cross-slope measurements (group of cards)

APPENDIX I

SAMPLE COMPUTER OUTPUT REPORT

EVALUATION OF RUNWAY SKID RESISTANCE CHARACTERISTIC AT RAF UPPER HEYFORD

INTRODUCTION

THIS REPORT CONTAINS A SUMMARY OF THE SIGNIFICANT DATA RESULTING FROM SKID RESISTANCE TESTS CONDUCTED AT RAF UPPER HEYFORD ON 22 NOV 72. THE TEST PROGRAM WAS CONDUCTED BY THE AIR FORCE WEAPONS LAB USING THE STANDARD SKID RESISTANCE TEST PROCEDURE DEVELOPED BY THE CIVIL ENGINEERING DIVISION OF THE AIR FORCE WEAPONS LABORATORY. THE FIELD TESTS WERE CONDUCTED (1) TO EVALUATE THE SKID RESISTANCE AND HYDROPLANING CHARACTERISTIC AT THE RUNWAY SURFACE (2) TO DETERMINE IF RCR VALUES CURRENTLY IN USE ARE APPROPRIATE AND (3) TO PROVIDE USAFE WITH AN OVERALL RANKING OF THE WET PERFORMANCE OF THE RUNWAYS TESTED TO ASSIST IN SELECTING RECOVERY BASES DURING INCLEMENT WEATHER.

TEST PROGRAM AND EQUIPMENT

THE SKID RESISTANCE/HYDROPLANING CHARACTERISTICS OF THE RUNWAY SURFACE WERE EVALUATED BY TWO TYPES OF TEST EQUIPMENT, THE MU-METER AND THE DIAGONALLY-BRAKED VEHICLE (DBV). THE TEST PROGRAM CONSISTED OF FIELD MEASUREMENTS OF THE PAVEMENT SKID RESISTANCE/HYDROPLANING POTENTIAL UNDER DRY AND STANDARDIZED ARTIFICIALLY WET CONDITIONS. IN ADDITION, TRANSVERSE SLOPE MEASUREMENTS WERE CONDUCTED FOR AREAS (APPROXIMATELY 20 FEET) ON EACH SIDE OF THE RUNWAY CENTERLINE TO EVALUATE THE SURFACE DRAINAGE CHARACTERISTICS.

TEST LOCATIONS

A TOTAL OF 5 TEST SECTIONS (EACH TYPICALLY 2000 FEET IN LENGTH) WERE SELECTED TO REFLECT A REPRESENTATIVE SAMPLING OF THE SKID RESISTANCE/HYDROPLANING

CHARACTERISTICS OF THE ENTIRE SURFACE. THE TEST SECTION LAYOUT IS SHOWN IN FIGURE 1. THE TEST SECTIONS WERE SELECTED TO EXAMINE THE PAVEMENT TRACTION IN (A) THE AIRCRAFT TOUCHDOWN AREAS, (B) THE RUNWAY INTERIOR IN THE MAJOR TRAFFIC PATHS WHERE MAXIMUM BRAKING IS NORMALLY DEVELOPED, AND (C) THE PAVEMENT EDGE WHICH IS REPRESENTATIVE OF A NON-TRAFFIC AREA.

WEATHER

THE TEMPERATURE DURING THE PERIOD OF TESTING RANGED BETWEEN 46 DEGREES AND 48 DEGREES FAHRENHEIT. WIND VELOCITY VARIED BETWEEN 10 AND 13 KNOTS.

EQUIPMENT

THE PRINCIPAL ITEMS OF FIELD TESTING EQUIPMENT CONSISTED OF THE MU-METER, THE DIAGONALLY BRAKED VEHICLE, TANK TRUCK FOR WATER APPLICATION, AND A DEVICE FOR THE MEASUREMENT OF THE SLOPE OF THE PAVEMENT SURFACE.

(A) THE MU-METER IS A SMALL TRAILER UNIT DESIGNED AND MANUFACTURED BY M. L. AVIATION (MAIDENHEAD, BIRKS, ENGLAND) FOR THE SPECIFIC PURPOSE OF EVALUATION OF THE COEFFICIENT OF FRICTION (MU) FOR RUNWAY SURFACES. THE MU-METER PHYSICALLY EVALUATES THE SIDE-SLIP FORCE BETWEEN THE TIRES AND PAVEMENT SURFACE. IT IS A CONTINUOUS RECORDING DEVICE THAT GRAPHICALLY RECORDS THE COEFFICIENT OF FRICTION (MU) VERSUS DISTANCE ALONG THE PAVEMENT. THIS SYSTEM IS ALSO EQUIPPED WITH INSTRUMENTATION WHICH INTEGRATES THE MU VERSUS DISTANCE CURVE TO OBTAIN THE AVERAGE COEFFICIENT OF FRICTION FOR SELECTED AREAS WITHIN A TEST RUN. THE MU-METER WAS OPERATED AT A CONSTANT SPEED OF 40 MPH, WHICH IS THE 1.2 TIMES THE THEORETICAL HYDROPLANING SPEED OF THIS VEHICLE.

(B) THE DBV IS A SPECIALLY DESIGNED AND HIGHLY INSTRUMENTED VEHICLE WHICH WAS DEVELOPED TO EVALUATE THE STOPPING CHARACTERISTICS OF RUNWAY SURFACES. THE AFWL VERSION IS IN A STATION WAGON CONFIGURATION. THE DBV CONCEPT WAS DEVELOPED BY NASA IN THE COMBAT TRACTION PROGRAM (NASA TN D-6098, NOVEMBER 1970). THE

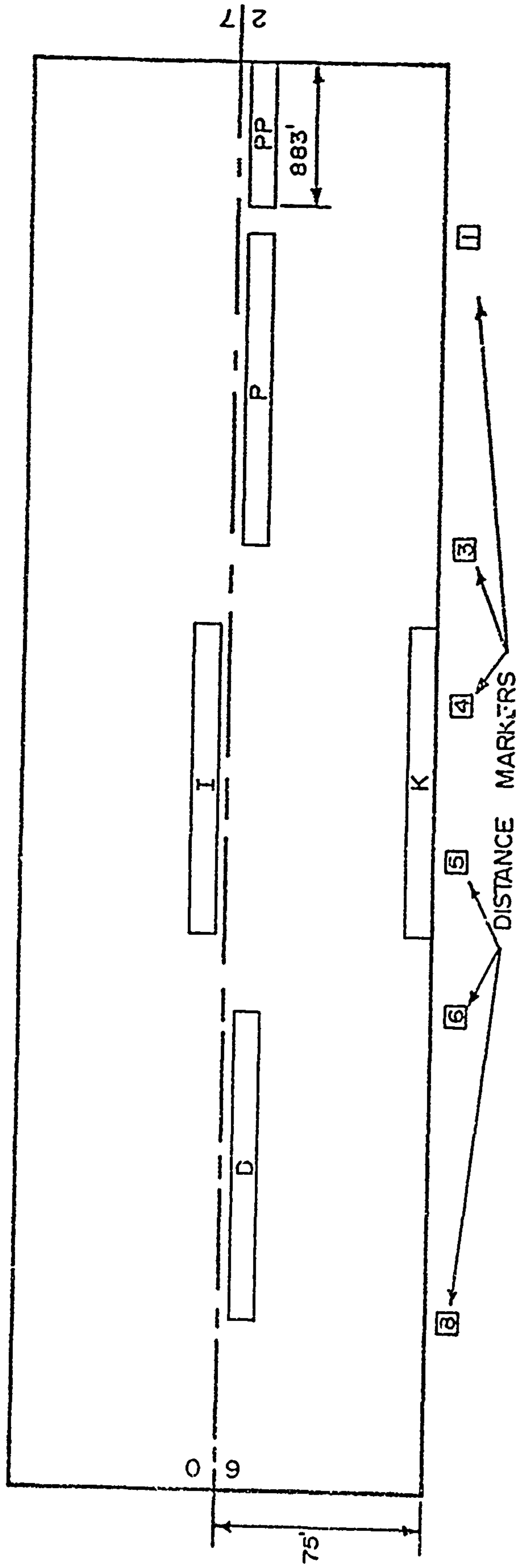


Figure 1. RAF Upper Heyford Layout of Test Sections

DBV PRIMARILY RECORDS THE STOPPING DISTANCE OF THE VEHICLE IN A LOCKED WHEEL MODE UNDER A DIAGONALLY BRAKED CONFIGURATION FROM 60 MPH. INSTRUMENTATION IN THE VEHICLE RECORDS SUCH PARAMETERS AS STOPPING DISTANCE, DECELERATION VERSUS DISTANCE, VELOCITY VERSUS DISTANCE, BRAKE PRESSURE, ETC.

(C) THE WATER DISTRIBUTION TRUCK WAS A LOCALLY FURNISHED VEHICLE EQUIPPED WITH A SPRAY BAR AND A MEANS TO PRECISELY CONTROL THE RATE OF WATER APPLICATION. THE WATER WAS APPLIED IN TWO PASSES, WITH THE TRUCK CAREFULLY CALIBRATED SO THAT EACH PASS PLACED 0.1 INCH OF WATER ON THE TEST STRIP. THE FIRST PASS WAS USED FOR AN INITIAL WETTING, AND TESTING FOLLOWED IMMEDIATELY AFTER THE SECOND PASS.

(D) THE SLOPE MEASURING DEVICE CONSISTED OF A RECTANGULAR SECTION OF ALUMINUM (10 FEET LONG, 5/8 INCHES THICK, AND 2 1/2 INCHES HIGH) WITH MACHINISTS LEVELS ATTACHED SO AS TO DEFINE SLOPES FROM 0 TO 2.0 PERCENT, TO THE NEAREST 0.1 PERCENT. THE SLOPE MEASURING DEVICE WAS USED TO MEASURE TRANSVERSE GRADIENTS IN THE WHEEL PATH AREAS, WITH MEASUREMENTS TAKEN AT TWO PLACES ON EACH SIDE OF THE RUNWAY CENTERLINE.

THE FIELD TEST PROCEDURE USED FOR THE EVALUATION OF THE SKID RESISTANCE/ HYDROPLANING CHARACTERISTICS OF THE RUNWAY SURFACE IS OUTLINED BRIEFLY BELOW.

(A) TEST AREAS (EACH TYPICALLY 2000 FEET LONG) WERE DETERMINED TO FURNISH A REPRESENTATIVE SAMPLING OF THE ENTIRE RUNWAY SURFACE (SEE FIGURE 1).

(B) TRANSVERSE SLOPE MEASUREMENTS WERE CONDUCTED ON EACH SIDE OF THE RUNWAY CENTERLINE AT THE INTERVALS SHOWN IN TABLE 2.

(C) THE WATER TRUCK WAS PRECISELY CALIBRATED TO DISCHARGE 0.1 INCH OF WATER EACH TIME IT PASSED OVER A GIVEN AREA.

(D) THE SKID RESISTANCE TEST FOR THE DRY PAVEMENT CONDITION WAS CONDUCTED USING THE DBV AND MU-METER. THE PAVEMENT SURFACE IN EACH TEST AREA WAS TYPICALLY EVALUATED IN BOTH DIRECTIONS.

(E) SKID RESISTANCE TESTS UNDER A STANDARDIZED ARTIFICALLY WET CONDITION WERE CONDUCTED AS FOLLOWS.

(1) WATER WAS APPLIED TO THE TEST AREA IN TWO PASSES. EACH PASS PLACED 0.1 INCH OF WATER.

(2) DBV AND MU-METER TESTS WERE CONDUCTED IMMEDIATELY FOLLOWING THE SECOND PASS OF THE WATER TRUCK. HALF THE TESTS WERE CONDUCTED IN EACH RUNWAY DIRECTION.

(3) ALL WATER TRUCK, MU-METER, AND DBV OPERATIONS WERE RECORDED VERSUS TIME TO THE NEAREST SECOND USING STOP WATCHES. THE SEQUENCE OF OPERATIONS WAS CONTROLLED BY RADIO.

TEST RESULTS

THE PAVEMENT SKID RESISTANCE RESULTS ARE REPORTED IN TERMS OF MU, COEFFICIENT OF FRICTION AS MEASURED BY THE MU-METER, AND THE SDR, WET TO DRY STOPPING DISTANCE RATIO AS MEASURED BY THE DIAGONALLY BRAKED VEHICLE. A SUMMARY OF THE TEST DATA IS PRESENTED IN TABLE 1. THESE RATING CHARTS WERE DEVELOPED FROM THE RESULTS OF THE AFWL RESEARCH PROGRAM AND THE JOINT NASA/FAA/AF TEST PROGRAM WITH ACTUAL AIRCRAFT. WHILE THE CURRENT STATE-OF-THE-ART PREVENTS A MORE PRECISE DELINEATION OF EXACT AIRCRAFT RESPONSES, TABLE 1 PROVIDES A GOOD RULE OF THUMB FOR INTERPRETATION OF THE DATA.

TABLE 1 PRESENTS THE AVERAGE SKID RESISTANCE VALUES OVER DIFFERENT AREAS OF THE RUNWAY. THE SIGNIFICANT DATA IS SHOWN FOR PERIODS OF 3, 15, AND 30 MINUTES AFTER WATER WAS APPLIED. THE POINT 3 MINUTES AFTER WATER APPLICATION CORRESPONDS TO A WET RUNWAY CONDITION AND 15 MINUTES AFTER WATER APPLICATION CORRESPONDS TO A DAMP RUNWAY CONDITION. TABLE 1 INDICATES HOW FAST THE SKID RESISTANCE PROPERTIES RECOVER AFTER THE VARIOUS SECTIONS OF THE RUNWAY SURFACE ARE WETTED. BY COMPARING THE ACTUAL MEASURED VALUES OF MU AND SDR SHOWN AT THE TOP OF TABLE 1

TABLE 1

DATA SUMMARY

COMBINED SECTIONS LOCATION	3 MIN. MU	3 MIN. SDR	15 MIN. MU	15 MIN. SDR	30 MIN. MU	30 MIN. SDR
PP TOUCHDOWN, PRIMARY	.58	2.48	.71	2.43	.77	3.14
D I P CENTER	.70	1.64	.81	1.53	.85	1.29
K EDGE	.62	1.49	.75	1.49	.83	1.46

MU-METER AIRCRAFT PAVEMENT RATING

MU	EXPECTED AIRCRAFT BRAKING RESPONSE	RESPONSE
GREATER THAN 0.50	GOOD	NO HYDROPLANING PROBLEMS ARE EXPECTED
0.42 - 0.50	FAIR	TRANSITIONAL
0.25 - 0.41	MARGINAL	POTENTIAL FOR HYDROPLANING FOR SOME A/C EXISTS UNDER CERTAIN WET CONDITIONS
LESS THAN 0.25	UNACCEPTABLE	VERY HIGH PROBABILITY FOR MOST AIRCRAFT TO HYROPLANE

STOPPING DISTANCE RATIO/AIRFIELD PAVEMENT RATING

SDR	HYDROPLANING POTENTIAL
1.0 - 2.0	NO HYDROPLANING ANTICIPATED.
2.0 - 2.5	POTENTIAL NOT WELL DEFINED.
2.5 - 3.5	POTENTIAL FOR HYDROPLANING.
GREATER THAN 3.5	VERY HIGH HYDROPLANING POTENTIAL

TO THE EXPECTED AIRCRAFT RESPONSE SHOWN AT THE BOTTOM OF THE TABLE, IT IS POSSIBLE TO JUDGE IF POTENTIAL HYDROPLANING PROBLEMS EXIST.

FRICTION VARIATION

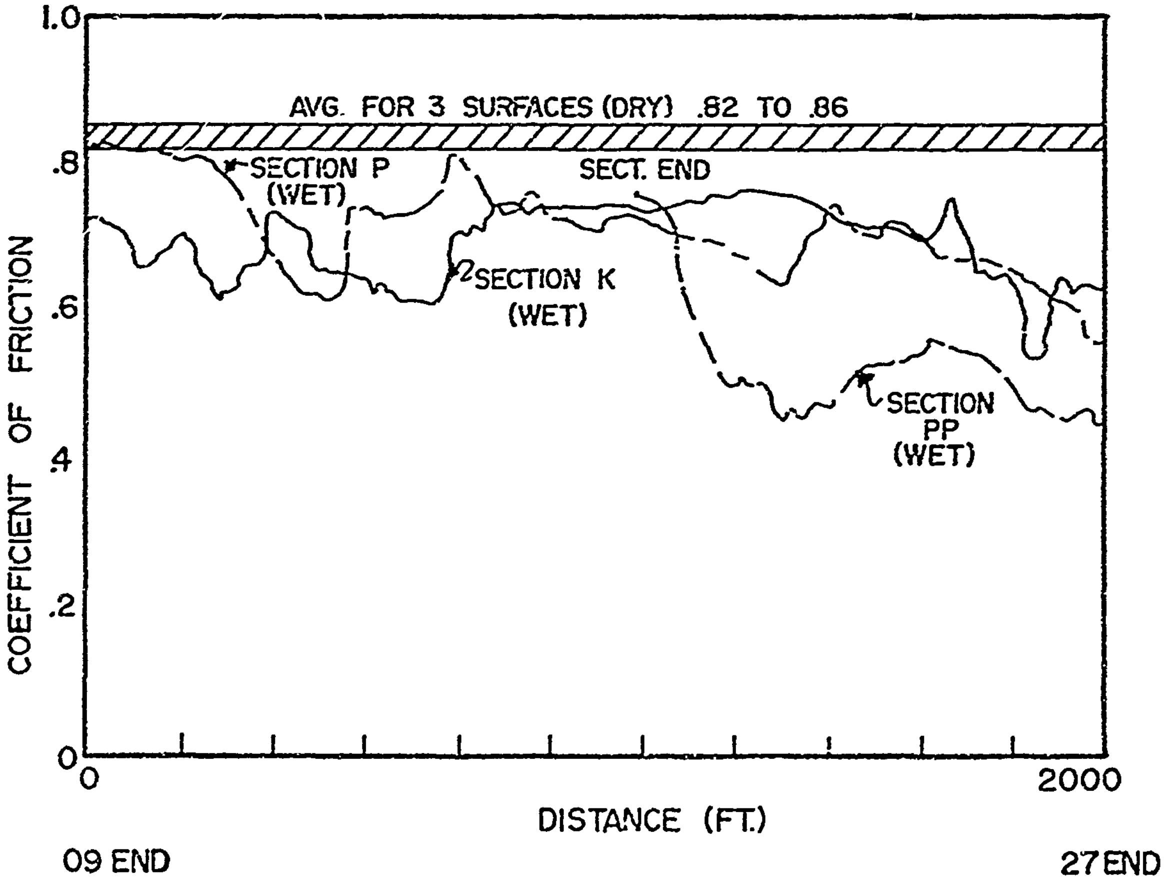
FIGURE 2 SHOWS THE ACTUAL FRICTION VERSUS DISTANCE TRACE AS RECORDED BY THE MU-METER DURING THE FIRST TEST RUN AFTER WETTING FOR TYPICAL AREAS OF THE RUNWAY SURFACE. IT SHOWS THE VARIATION OF FRICTION WITHIN 2000 FEET TEST SECTIONS, AND COMPARES THESE RESULTS WITH THE DRY PAVEMENT CONDITION. SHARP DIPS IN THE CURVE INDICATE LOWER FRICTION VALUES AT THESE POINTS, AND PROBABLY RESULT FROM ONE OF SEVERAL CAUSES--PONDING OF WATER, LOCAL SLICK SPOTS, ETC. APPENDIX A CONTAINS CHARTS SUMMARIZING ALL TEST RESULTS FROM THE DBV AND THE MU-METER RUNS. EACH CHART CONTAINS COMPLETE INFORMATION ABOUT A SINGLE TEST SECTION.

FRICTION RECOVERY WITH TIME

APPENDIX B CONTAINS GRAPHS FOR EACH TEST SECTION SHOWING THE EFFECT OF TIME AFTER WETTING (INVERSE OF WATER DEPTH) TO CHANGES IN SURFACE FRICTION AND ON THE STOPPING DISTANCE RATIO OF THE DBV. THESE GRAPHS DEMONSTRATE THE NATURAL DRAINAGE CHARACTERISTICS OF THE RUNWAY SURFACE AND THE TIME REQUIRED FOR THE SKID RESISTANCE PROPERTIES OF EACH TEST SECTION TO RETURN TO A DRY PAVEMENT CONDITION. THESE CURVES WERE DERIVED BY PLOTTING THE AVERAGE COEFFICIENT OF FRICTION OVER THE TOTAL TEST SECTION VERSUS TIME AFTER WETTING AND THE DBV STOPPING DISTANCE RATIOS OVER THE DBV PORTION OF THE TEST SECTION VERSUS TIME AFTER WETTING.

TRANSVERSE SURFACE SLOPE

TABLE 2 SHOWS THE MEASURED SURFACE SLOPES ALONG BOTH SIDES OF THE RUNWAY CENTERLINE. POSITIVE SLOPES INDICATE WATER DRAINS TO THE RUNWAY EDGE (WITHOUT CROSSING THE CENTERLINE), WHILE NEGATIVE SLOPES INDICATE THE DRAINAGE PATTERN



SECTION P, RUNWAY CENTER, AVG. Mu = .72
SECTION K, RUNWAY EDGE, AVG. Mu = .71
SECTION PP, RUBBER DEPOSITED AREA, AVG. Mu = .52

Figure 2. Typical Mu-Meter Traces for Test Sections of the Pavement Surfaces at RAF Upper Heyford

TABLE 2

RAF UPPER HEYFORD

DATA FROM CROSS-SLOPE MEASUREMENTS

DISTANCE MARKERS FROM WEST	PER CENT	PER CENT	CENTER LINE PER CENT	PER CENT
0+000	1.5	1.5	-.9	-1.1
0+500	1.5	1.4	-1.8	-1.5
1+000	1.5	1.5	-1.8	-1.2
1+500	1.1	1.4	-.8	-1.2
2+000	1.8	1.6	-.6	-1.8
2+500	1.6	1.1	-1.4	-.9
3+000	1.4	1.9	-1.1	-.9
3+500	1.8	1.8	-.9	-1.1
4+000	1.4	1.5	-1.1	-1.1
5+000	1.2	1.5	-1.3	-1.3
5+500	1.3	1.4	-1.4	-1.3
6+000	.9	2.0	-1.3	-1.6
6+500	1.7	1.1	-1.2	-1.4
7+000	1.6	1.4	-.9	-1.9
7+500	1.6	1.4	-1.4	-.8
8+000	1.1	1.8	-1.1	-1.1
8+500	1.3	1.7	-1.8	-1.3
9+000	1.4	1.4	-1.2	-1.4

CROSSES THE RUNWAY CENTERLINE BEFORE DRAINING TO THE EDGE. IN GENERAL, SURFACE SLOPES IN EXCESS OF ONE PERCENT PROMOTE GOOD TO EXCELLENT DRAINAGE CONDITIONS. THE DRAINAGE CHARACTERISTICS OF THE RUNWAY TESTED CAN BE RATED IN TERMS OF THIS GENERAL STATEMENT.

RCR CONVERSION

IN ORDER TO PROVIDE VALUES EQUIVALENT TO THE RCR NOW IN USE FOR RATING PAVEMENT SURFACES, THE STANDARD AFWL TEST INCORPORATES A CONVERSION ABILITY FROM DBV SDR TO EQUIVALENT RCR. THIS CONVERSION METHOD WAS REPORTED IN NASA REPORT TN D-6098. WHILE THE CONVERSION METHOD HAS NOT BEEN THOROUGHLY VERIFIED FOR ALL TYPES OF AIRCRAFT, IT IS CURRENTLY USED AS THE BEST METHOD AVAILABLE TO OBTAIN AN EQUIVALENT RCR FOR A GIVEN RUNWAY.

USING THE METHOD OF CONVERSION REPORTED BY NASA, THE RCR VALUES FOR THE RUNWAY DESCRIBED IN THIS REPORT ARE AS FOLLOWS

WET CONDITION	14
DAMP CONDITION	16

NOTE: Discussions, conclusions, and recommendations must be individually prepared for each base.

APPENDIX A

SUMMARY CHARTS

RAF UPPER HEYFORD

TEST AREA	RUN NO.	SURFACE CONDITION	HEADING	MU-METER AVG TIME AFTER WET	MU-METER MU MIN	MU-METER MU MAX	MU-METER MU AVG(1)	AVG TIME AFTER WET	D B V WET STOP DIST	D B V DRY STOP DIST	SDR(2) 3[illegible]0
D	1	DRY	9				.84			334	
D	2	DRY	27				.83			345	
D	1	WET	9	2.34	.48	.71	.65	1.84	489		1.67
D	2	WET	27	4.22	.50	.77	.65	4.29	486		1.62
D	3	WET	9	5.99	.36	.72	.62	6.00	446		1.49
D	4	WET	27	7.84	.50	.78	.73	7.87	506		1.69
D	5	WET	9	9.52	.36	.80	.71	9.60	479		1.60
D	6	WET	27	13.34	.50	.81	.77	13.14	474		1.58
D	7	WET	9	20.70	.48	.82	.77	20.00	398		1.33
D	8	WET	27	22.37	.49	.85	.78	27.93	430		1.43
D	9	WET	9	25.97	.74	.83	.81				
D	10	WET	27	28.32	.74	.87	.82				

(1) INTEGRATED COEFFICIENT FOR EACH TEST LANE
(2) COMPUTED USING DRY STOPPING DISTANCE OF 3[illegible]0 FEET

RAF UPPER HEYFORD

TEST AREA	RUN NO.	SURFACE CONDITION	HEADING	MU-METER AVG TIME AFTER WET	MU-METER MU MIN	MU-METER MU MAX	MU-METER MU AVG(1)	AVG TIME AFTER WET	DBV WET STOP DIST	DBV DRY STOP DIST	SDR(2) 300
I	1	DRY	27				.84			317	
I	2	DRY	9				.86			334	
I	1	WET	27	2.42	.50	.81	.68	1.86	453		1.51
I	2	WET	9	4.28	.60	.84	.75	4.48	427		1.42
I	3	WET	27	6.03	.74	.84	.81	6.26	437		1.46
I	4	WET	9	9.07	.72	.87	.83	8.15	456		1.52
I	5	WET	27	9.97	.72	.86	.83	10.02	403		1.34
I	6	WET	9	11.87	.74	.88	.83	12.01	404		1.35
I	7	WET	27	20.23	.76	.86	.82	26.21	361		1.20
I	8	WET	9	21.75	.82	.88	.86	28.00	386		1.29
I	9	WET	27	25.99	.81	.86	.88				
I	10	WET	9	26.77	.82	.89	.93				
I	11	WET	27	56.14	.80	.84	.85				
I	12	WET	9	58.58	.84	.86	.86				

(1) INTEGRATED COEFFICIENT FOR EACH TEST LANE
(2) COMPUTED USING DRY STOPPING DISTANCE OF 300 FEET

RAF UPPER HEYFORD

TEST AREA	RUN NO.	SURFACE CONDITION	HEADING	MU-METER AVG TIME AFTER WET	MU-METER MU MIN	MU-METER MU MAX	MU-METER MU AVG(1)	D 3 V AVG TIME AFTER WET	D 3 V WET STOP DIST	D 3 V DRY STOP DIST	SDR(2) 300
P	1	DRY	27				.83			325	
P	2	DRY	9							329	
P	1	WET	27	2.62	.60	.80	.72	1.75	543		1.61
P	2	WET	9	4.27	.64	.78	.73	4.50	517		1.72
P	3	WET	27	5.73	.64	.84	.75	6.04	550		1.83
P	4	WET	9	7.34	.60	.81	.76	7.63	569		1.90
P	5	WET	27	8.83	.68	.86	.79	9.11	542		1.81
P	6	WET	9	9.48	.66	.84	.81	10.76	542		1.81
P	7	WET	27	20.35	.74	.86	.80	26.33	420		1.40
P	8	WET	9	21.76	.72	.86	.87	27.91	420		1.40
P	9	WET	27	26.08	.70	.84	.84				
P	10	WET	9	27.64	.76	.86	.86				
P	11	WET	27	32.73	.75	.84	.83				
P	12	WET	9	54.34	.78	.83	.88				

(1) INTEGRATED COEFFICIENT FOR EACH TEST LANE
(2) COMPUTED USING DRY STOPPING DISTANCE OF 300 FEET

.RAF UPPER HEYFORD

TEST AREA	RUN NO.	SURFACE CONDITION	HEADING	MU-METER AVG TIME AFTER WET	MU-METER MU MIN	MU-METER MU MAX	MU-METER MU AVG(1)	AVG TIME AFTER WET	D B V WET STOP DIST	D B V DRY STOP DIST	SDR(2) 300
PP	1	DRY	27				.82			272	
PP	2	DRY	9							329	
PP	1	WET	27	2.17	.44	.56	.52	1.63	750		2.50
PP	2	WET	9	4.85	.54	.67	.65	25.73	708		2.36
PP	3	WET	27	5.92	.58	.66	.64	22.34	605		2.02
PP	4	WET	9	7.22	.52	.69	.63	25.73	708		2.36
PP	5	WET	27	8.35	.59	.70	.65	27.13	616		2.05
PP	6	WET	9	9.76	.54	.76	.63	28.59	722		2.41
PP	7	WET	27	16.65	.66	.76	.76				
FF	8	WET	9	13.08	.64	.78	.73				
PP	9	WET	27	24.67	.66	.76	.74				
PP	10	WET	9	26.33	.65	.78	.80				
PP	11	WET	27	27.67	.70	.78	.78				
FF	12	WET	9	29.13	.70	.82	.72				

(1) INTEGRATED COEFFICIENT FOR EACH TEST LANE
(2) COMPUTED USING DRY STOPPING DISTANCE OF 300 FEET

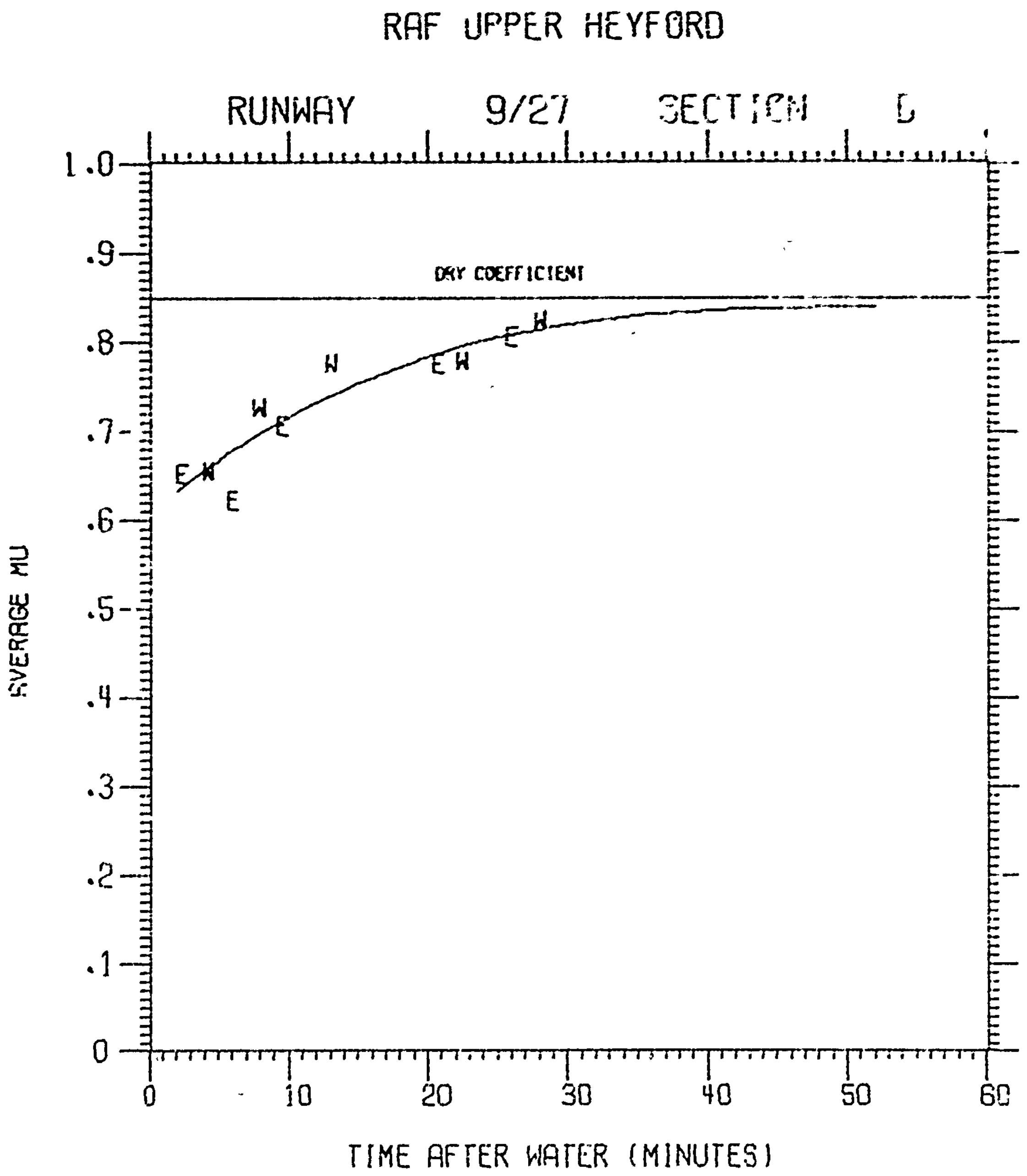
RAF UPPER HEYFORD

TEST AREA	RUN NO.	SURFACE CONDITION	HEADING	MU-METER AVG TIME AFTER WET	MU-METER MU MIN	MU-METER MU MAX	MU-METER MU AVG(1)	AVG TIME AFTER WET	DBV WET STOP DIST	DBV DRY STOP DIST	SDR(2) 300
K	1	DRY	27				.85			313	
K	2	DRY	9							325	
K	1	WET	27	2.46	.32	.72	.58	1.09	485		1.62
K	2	WET	9	4.27	.53	.72	.62	4.42	423		1.41
K	3	WET	27	5.91	.55	.76	.71	6.13	425		1.42
K	4	WET	9	8.71	.55	.77	.69	7.89	419		1.40
K	5	WET	27	10.24	.53	.75	.72	9.46	479		1.60
K	6	WET	9	11.95	.62	.72	.69	11.16	428		1.43
K	7	WET	27					25.37	454		1.51
K	8	WET	9					25.84	454		1.51

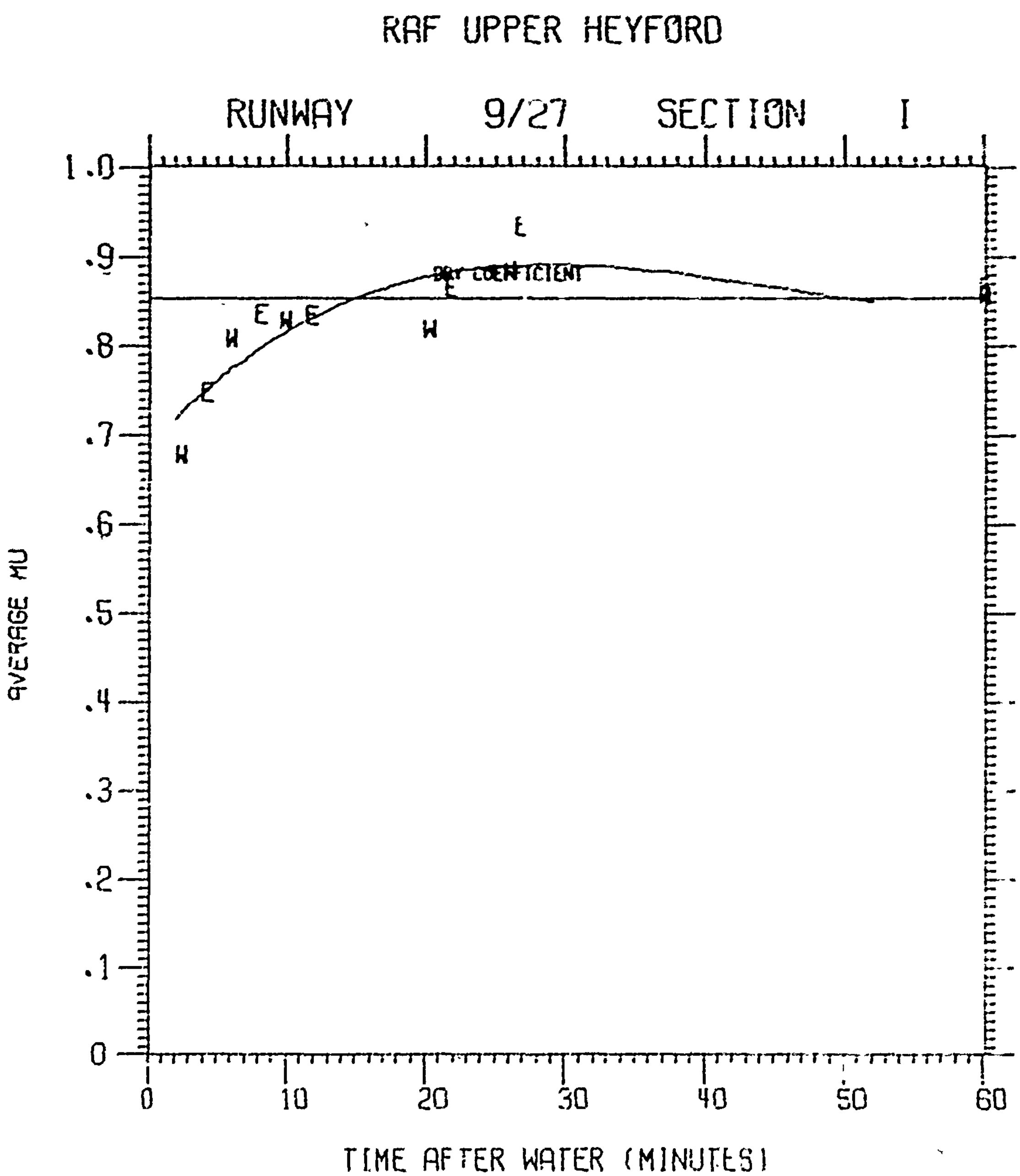
(1) INTEGRATED COEFFICIENT FOR EACH TEST LANE
(2) COMPUTED USING DRY STOPPING DISTANCE OF 300 FEET

APPENDIX B

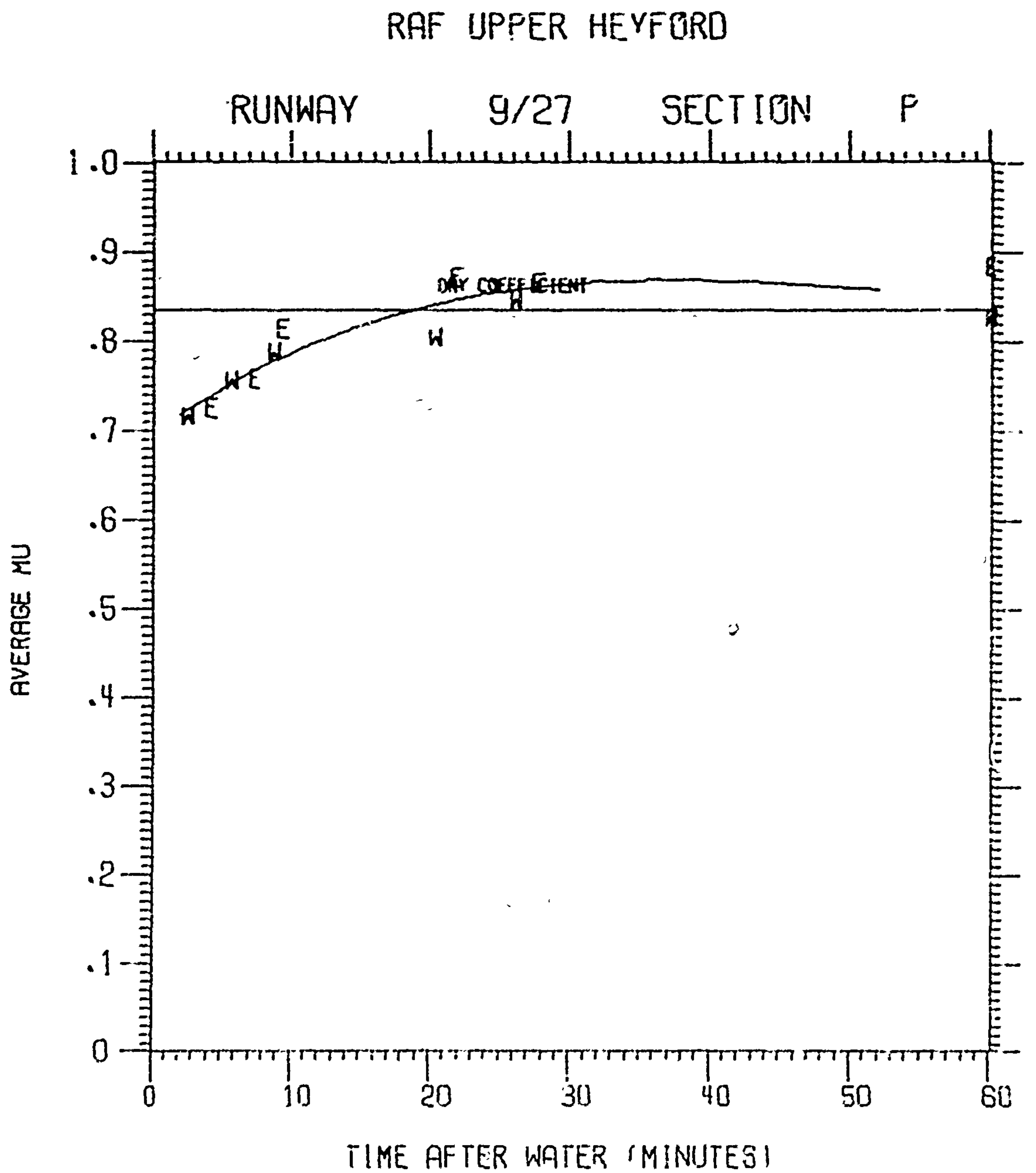
GRAPHS


RAF UPPER HEYFORD
RUNWAY 9/27 SECTION D
DRY COEFFICIENT
AVERAGE MU
1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
0
0
10
20
30
40
50
60
TIME AFTER WATER (MINUTES)

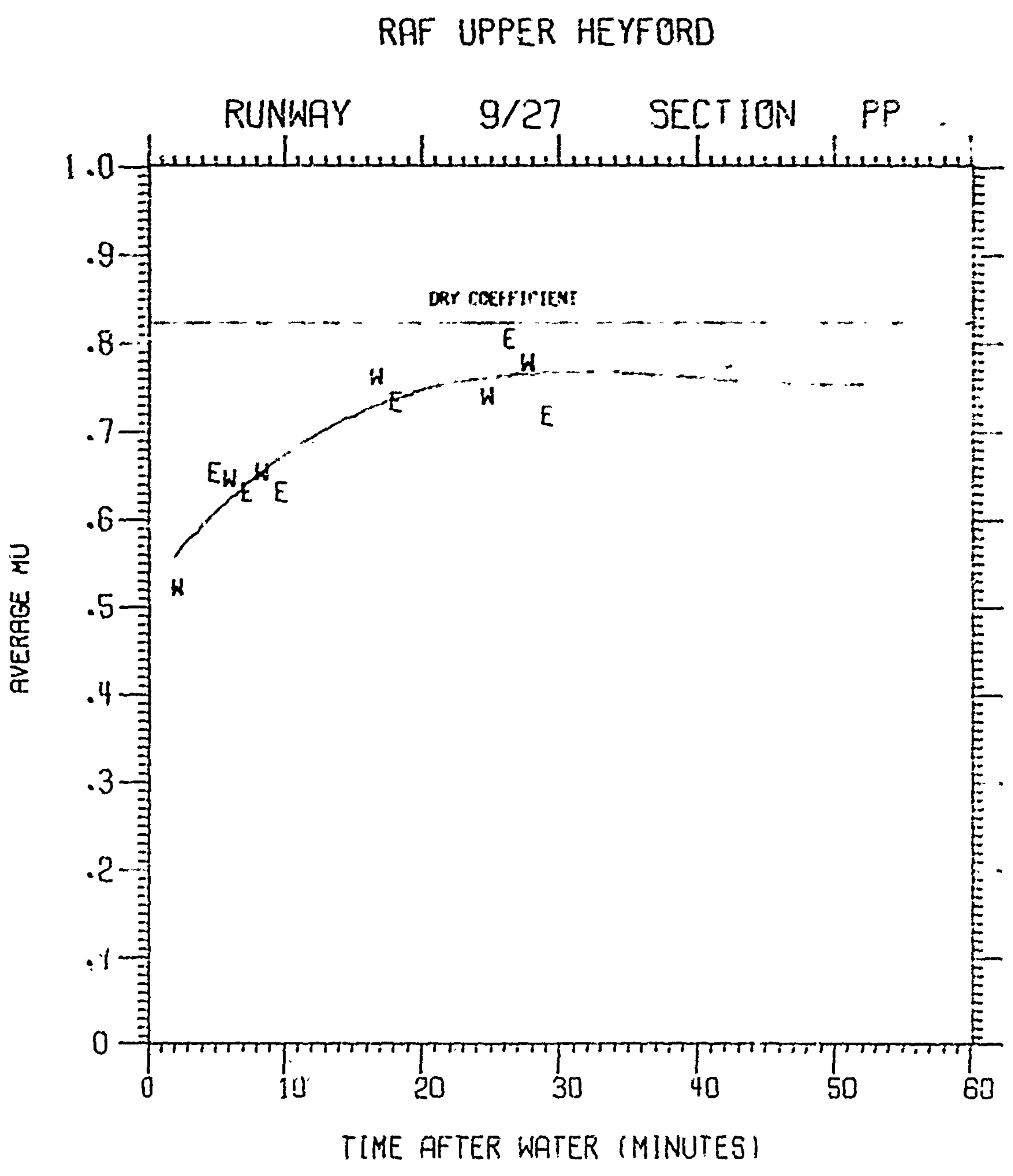
1


RAF UPPER HEYFORD
RUNWAY 9/27 SECTION I
DRY COEFFICIENT
AVERAGE MU
1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
0
0
10
20
30
40
50
60
TIME AFTER WATER (MINUTES)

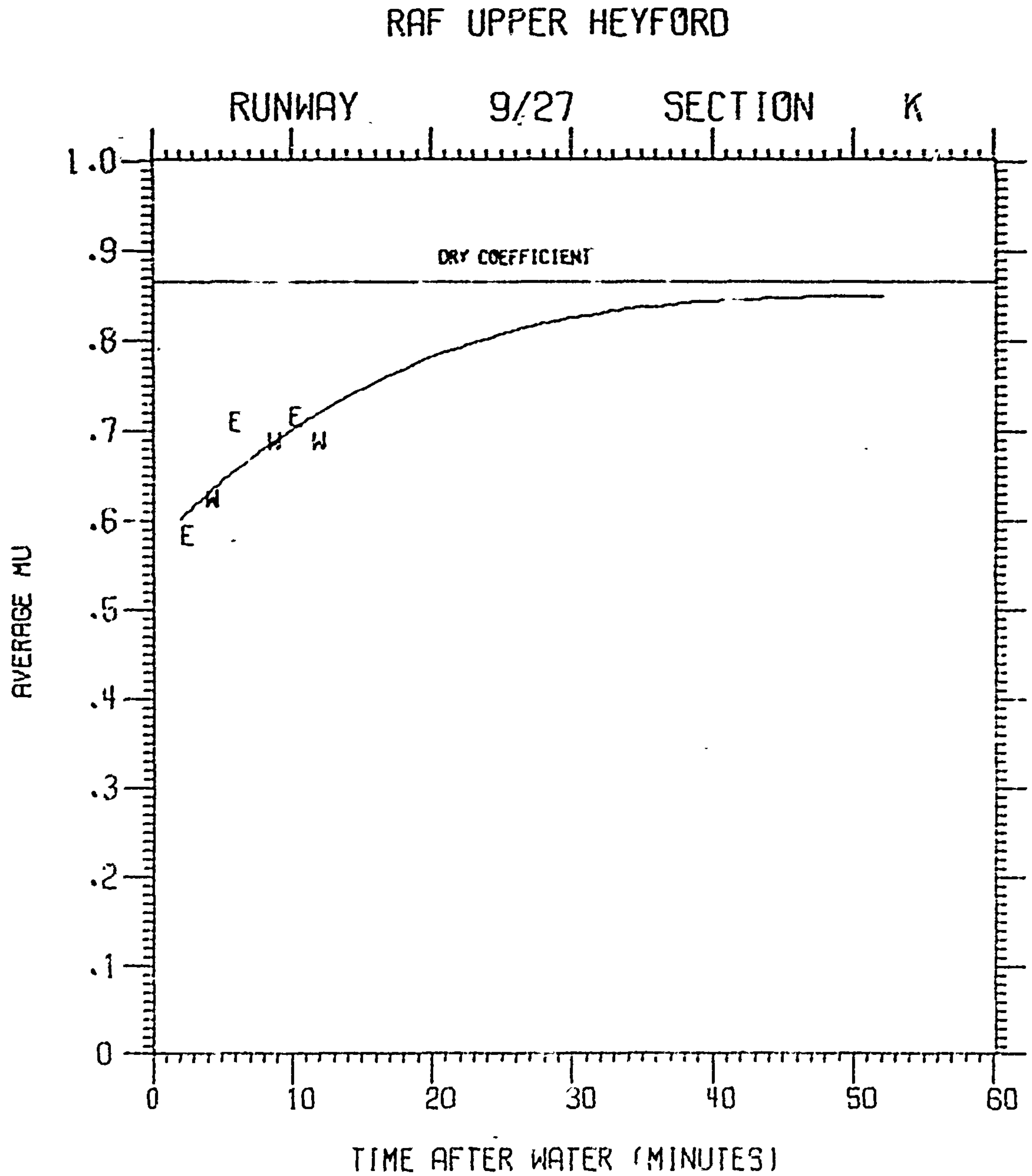
2


RAF UPPER HEYFORD
RUNWAY 9/27 SECTION P
DRY COEFFICIENT
AVERAGE MU
1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
0
0
10
20
30
40
50
60
TIME AFTER WATER (MINUTES)

3


RAF UPPER HEYFORD
RUNWAY 9/27 SECTION PP
DRY COEFFICIENT
AVERAGE MU
1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
0
0
10
20
30
40
50
60
TIME AFTER WATER (MINUTES)

4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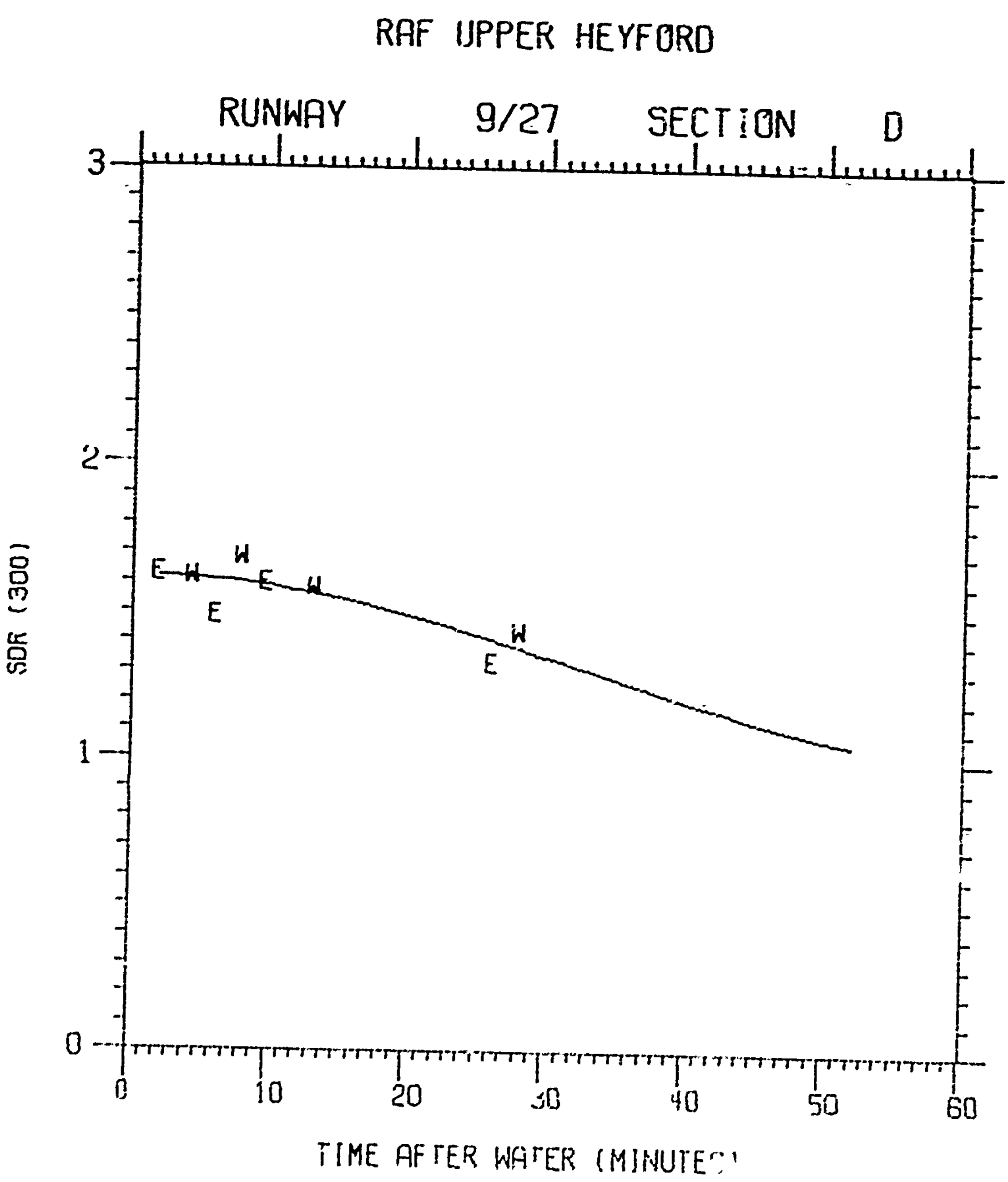
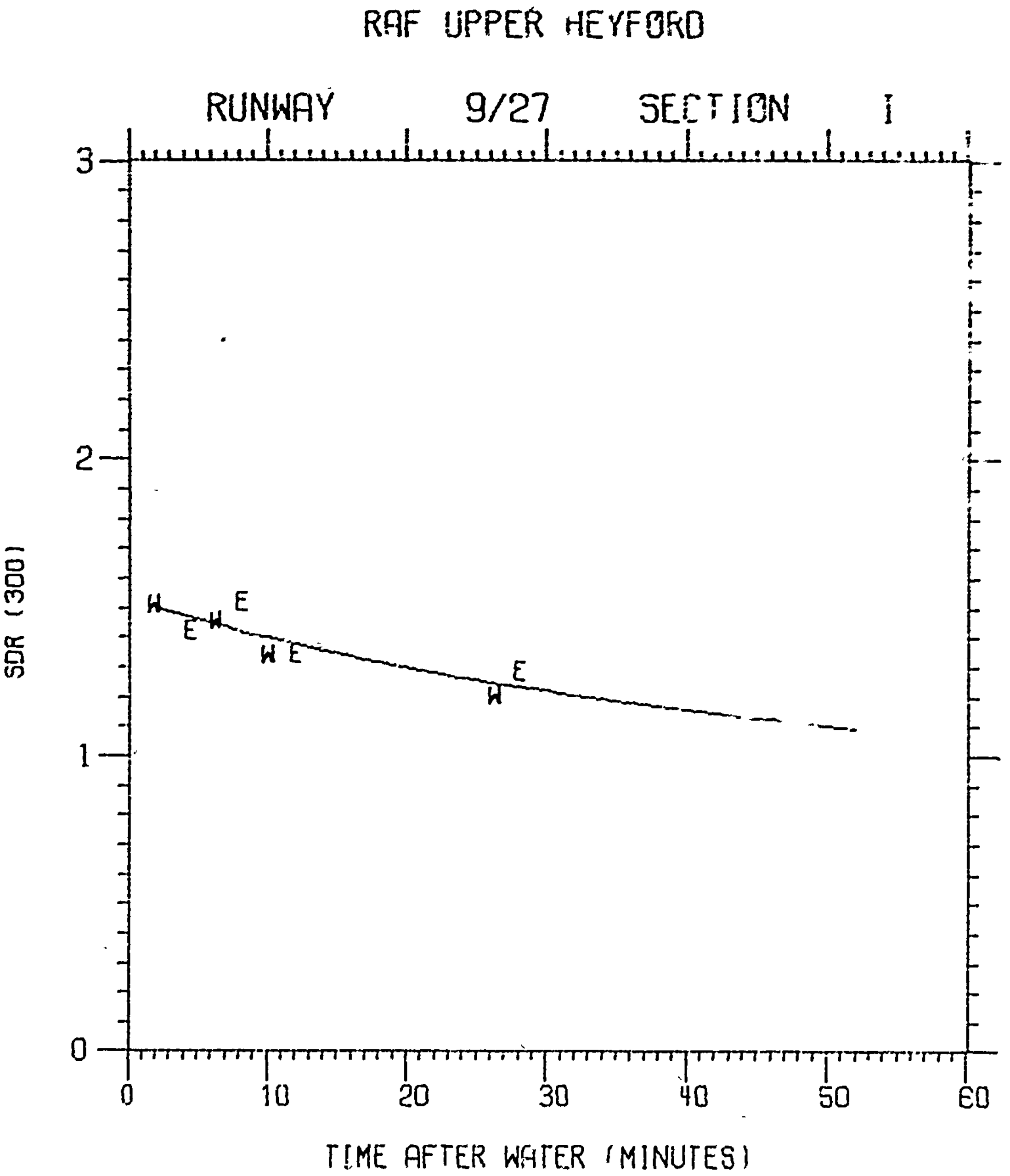
RUNWAY 9/27 SECTION K
DRY COEFFICIENT
AVERAGE MU
1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
0
0
10
20
30
40
50
60
TIME AFTER WATER (MINUTES)
E
W
E
W
E
W

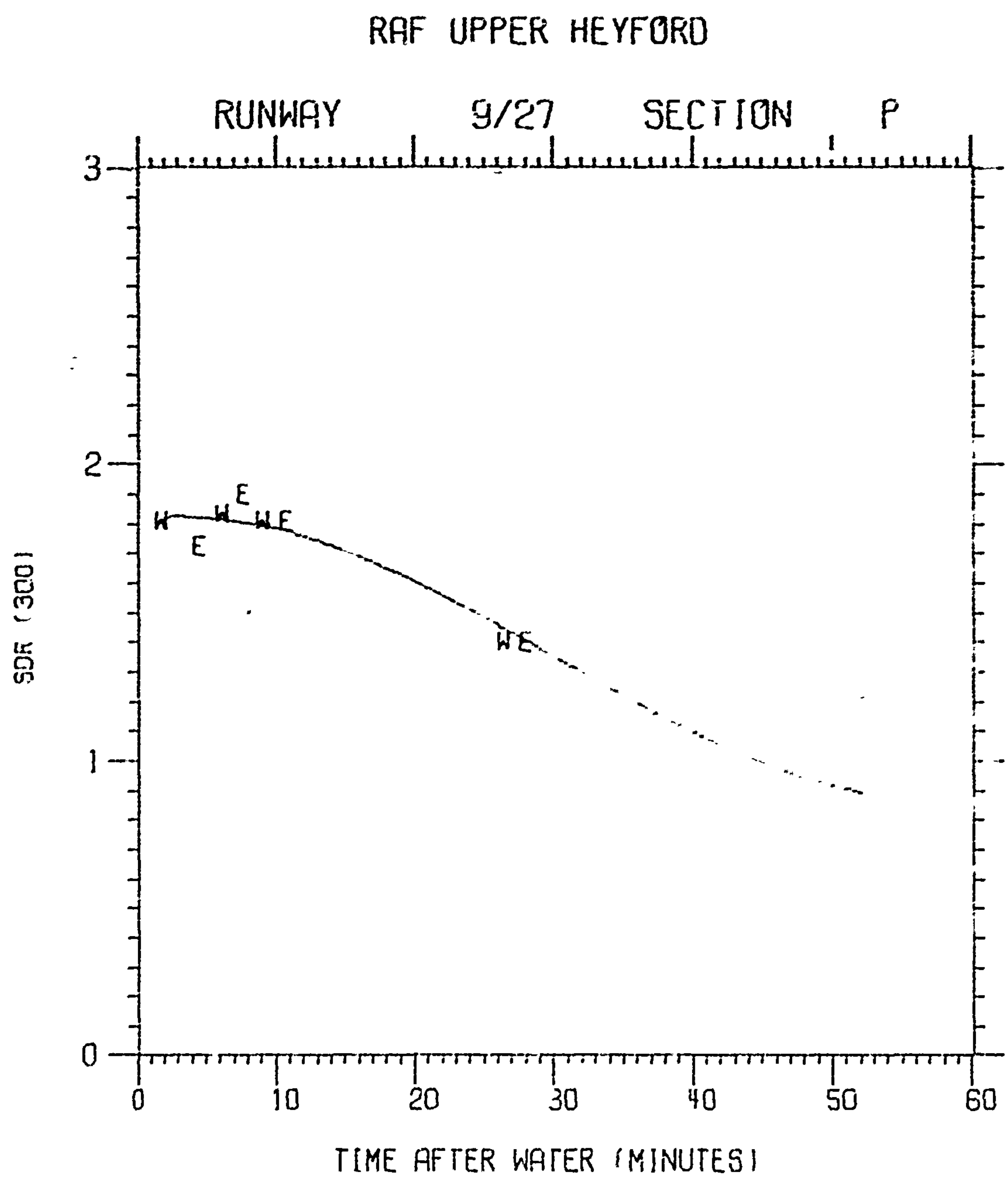
5


RAF UPPER HEYFORD
RUNWAY 9/27 SECTION D
SDR (300)
TIME AFTER WATER (MINUTES)
3
2
1
0
0
10
20
30
40
50
60
E
W

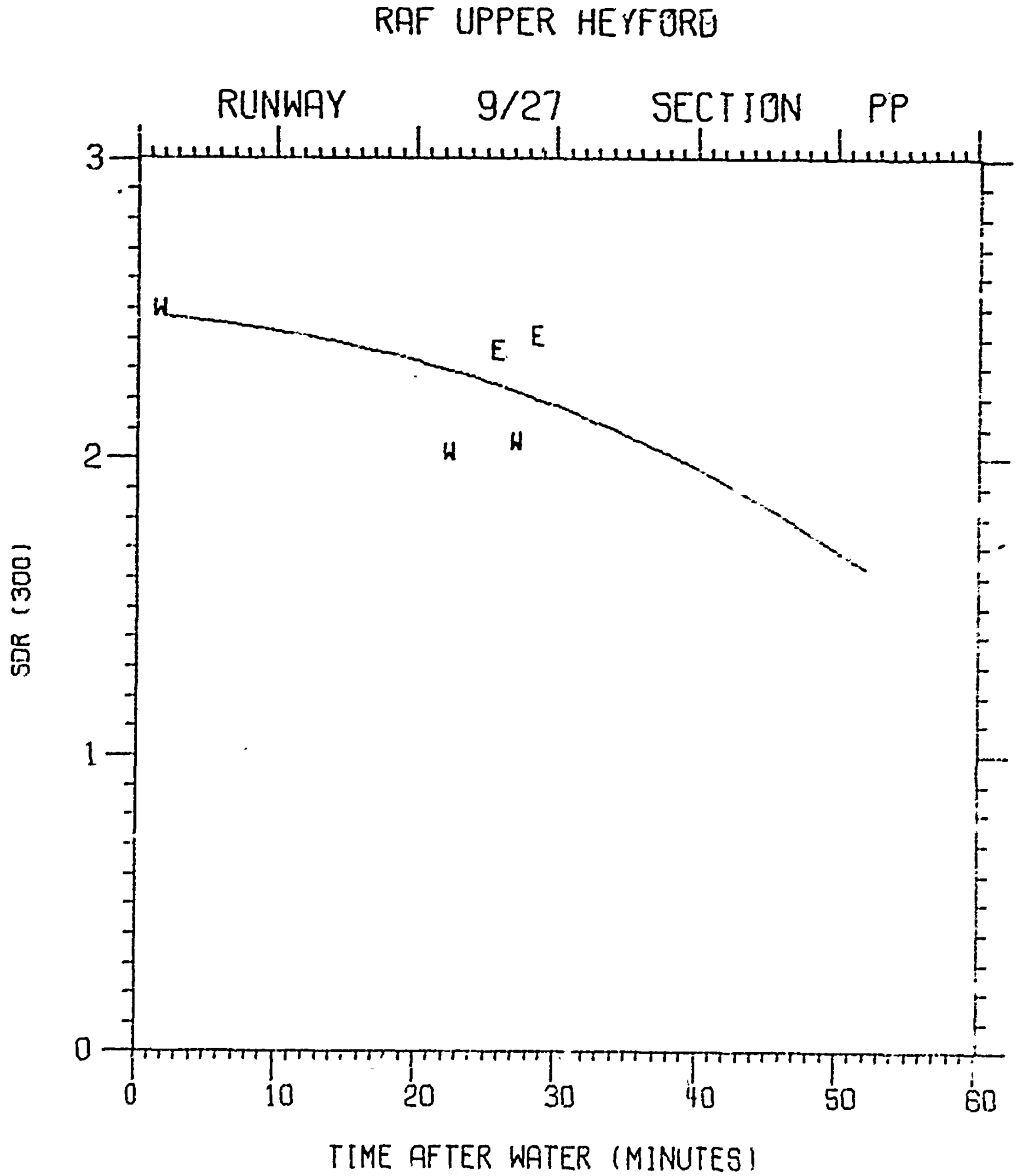
1


RAF UPPER HEYFORD
RUNWAY 9/27 SECTION I
SDR (300)
0
1
2
3
0
10
20
30
40
50
60
W
E
TIME AFTER WATER (MINUTES)

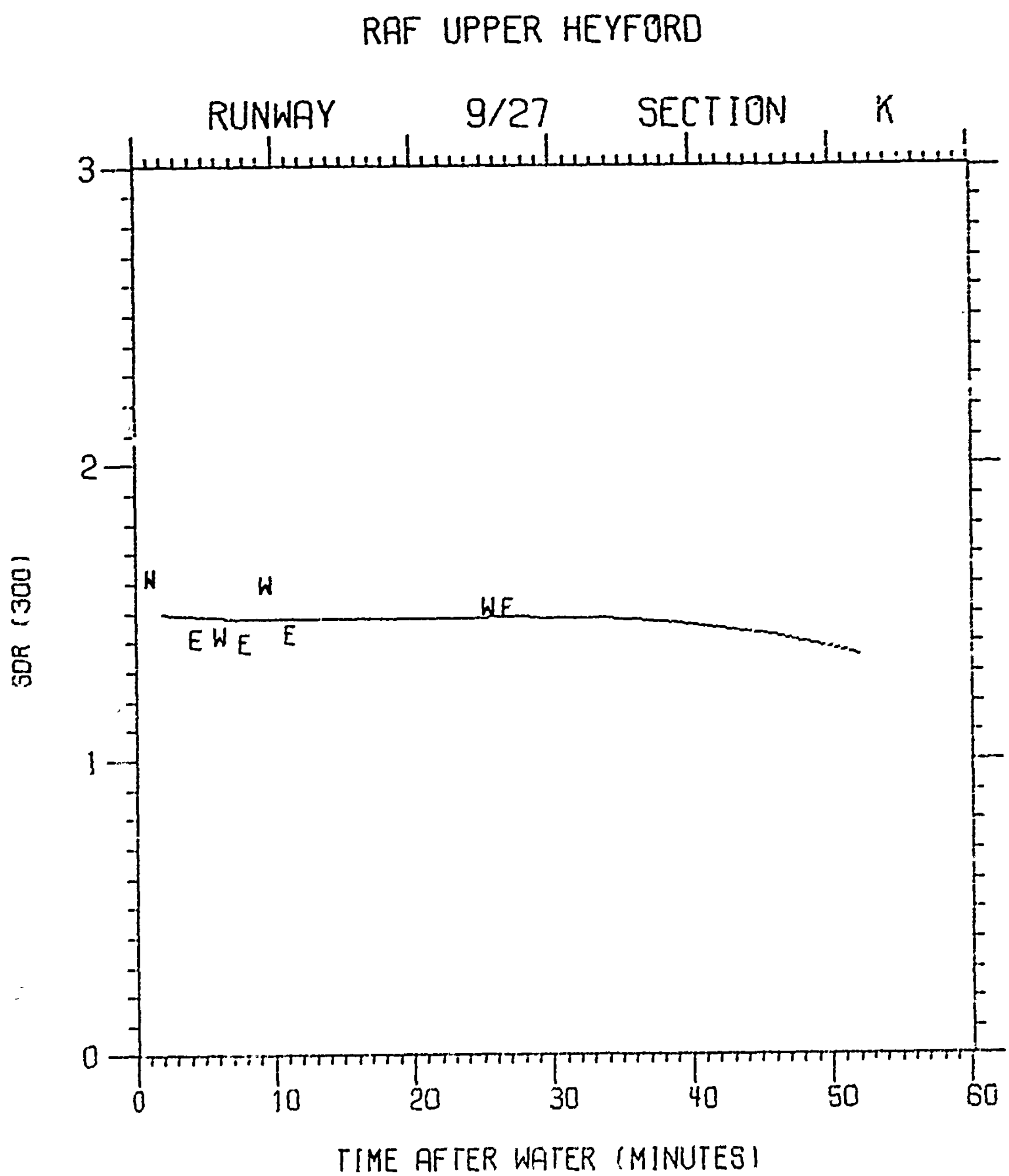
2


RAF UPPER HEYFØRD
RUNWAY 9/27 SECTION P
SDR (300)
0
1
2
3
0
10
20
30
40
50
60
TIME AFTER WATER (MINUTES)
W
E

3


RAF UPPER HEYFORD
RUNWAY 9/27 SECTION PP
SDR (300)
3
2
1
0
W
E
E
W
W
0
10
20
30
40
50
60
TIME AFTER WATER (MINUTES)

4


RAF UPPER HEYFORD
RUNWAY 9/27 SECTION K
SDR (300)
TIME AFTER WATER (MINUTES)
0
1
2
3
0
10
20
30
40
50
60
W
W
E W E E
WE

5

APPENDIX II

BLANK FORMS AND CHECK LISTS

HEADER CARD NO.1

BASE NAME																				NO. SECTIONS TESTED					
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26

EXAMPLE

				K	I	R	T	L	A	N	D		A	F	B								1	Ø	

AGENCY PERFORMING TEST																																	
27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60

EXAMPLE

A	I	R		F	O	R	C	E		C	I	V	I	L		E	N	G	I	N	E	E	R	I	N	G		C	E	N	T	E	R

NO. CARDS USED TO LIST REASONS FOR TEST (MAX=4)									
61	62	63	64	65	66	67	68	69	70

EXAMPLE

									1

NOTES: O = LETTER O

Ø = ZERO

"BASE NAME" AND "AGENCY PERFORMING TEST" SHOULD BE CENTERED IN THE SPACE PROVIDED.

FIELD FOR "NO. SECTIONS TESTED" IS RIGHT JUSTIFIED. THIS MEANS ANY BLANK SPACES APPEAR AT THE LEFT OF THE FIELD.

HEADER CARD GROUP NO. 2

USE ALL OR ANY PORTION OF THE 4 CARDS BELOW TO RECORD REASONS FOR THE TEST (OTHER THAN EVALUATION OF SKID RESISTANCE) NUMBERED BEGINNING WITH (2).

CARD 1

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40

41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80

CARD 2

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40

41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80

CARD 3

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40

41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80

CARD 4

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40

41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80

EXAMPLE

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
(	2	)	T	O		R	E	C	O	M	M	E	N	D		C	O	R	R	E	C	T	I	V	E		A	C	T	I	O	N	,		I	F		I	N

41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
D	I	C	A	T	E	D		(	3	)	T	O		C	H	E	C	K		R	C	R		V	A	L	U	E	S		I	N		U	S	E	.		

HEADER CARD NO.3

NO. SECTIONS TO BE COMBINED FOR OVERALL RATING OF PRIMARY TOUCHDOWN AREA									
1	2	3	4	5	6	7	8	9	10

DESIGNATION OF PRIMARY TOUCHDOWN SECTIONS									
11	12	13	14	15	16	17	18	19	20

NO. SECTIONS TO BE COMBINED FOR OVERALL RATING OF RUNWAY CENTER (MAX.=4)									
21	22	23	24	25	26	27	28	29	30

DESIGNATION OF CENTER SECTIONS									
31	32	33	34	35	36	37	38	39	40

NO. SECTIONS TO BE COMBINED FOR OVERALL RATING OF SECONDARY TOUCHDOWN AREA (MAX=4)									
41	42	43	44	45	46	47	48	49	50

DESIGNATION OF SECONDARY TOUCHDOWN SECTIONS									
51	52	53	54	55	56	57	58	59	60

NO. SECTIONS TO BE COMBINED FOR OVERALL RATING OF RUNWAY EDGE (MAX.=4)									
61	62	63	64	65	66	67	68	69	70

DESIGNATION OF EDGE SECTIONS									
71	72	73	74	75	76	77	78	79	80

EXAMPLE

									3

		B	B		C	P	P		

NOTES: O = LETTER
Ø = ZERO
WHEN DESIGNATING TEST SECTIONS TO BE COMBINED, SKIP A SPACE BEFORE AND AFTER THE LETTER DESIGNATION, UNLESS THE SECTION IS DESIGNATED BY A DOUBLE LETTER, SUCH AS "BB." SEE EXAMPLE ABOVE.

GENERAL INFORMATION, WEATHER, AND WATER RECORD

RECORDER ____________________

GENERAL INFORMATION

	BASE ABBREVIATION		TEST STRIP		RUNWAY IDENT.	TEST STRIP DESCRIPTION	
Columns	1 2 3 4 5 6	7 8	9 10	11 12 13 14 15	16 17 18 19 20	21 22 23 24 25 26	27
Entry					_ _ / _ _		
EXAMPLE	L K N H T H		A		Ø 6 / 2 4	R U B B E R	

WEATHER INFORMATION

	TEMP. °F		DEW PT. °F		WIND DIR.		WIND VEL.		GUST. WIND VEL.
Columns	28 29 30	31 32 33	34 35	36	37 38 39	40	41 42	43	44 45
Entry									
EXAMPLE	6 Ø		4 8		2 7 Ø		2 Ø		2 5

WATER RECORD

		WATER 'IN', TOT. STRIP						WATER 'IN', DBV STRIP						WATER 'OUT', TOT. STRIP				
		HR.		MIN.		SEC.		HR.		MIN.		SEC.		HR.		MIN.		SEC.
Columns	46	47 48	49	50 51	52	53 54	55	56 57	58	59 60	61	62 63	64	65 66	67	68 69	70	71 72
Entry																		
EXAMPLE		1 4		4 1		Ø 5		1 4		4 1		4 8		1 4		4 5		Ø 1

ZERO WATER TIME				
HR.		MIN.		SEC.

NOTES: O = LETTER O
Ø = ZERO
ALL DATA IS RIGHT JUSTIFIED. THIS MEANS ANY BLANK SPACES APPEAR AT THE LEFT OF THE FIELD.

GENERAL INFORMATION

BASE ______________________ RUNWAY ______________

RECORDER ______________________ DATE ______________

TEST SECTION ____________________

TYPE PAVEMENT	LONG. SLOPE	TRANS-VERSE SLOPE	SECTION LENGTH	DIST. FROM ℄	DIST. TO START OF DBV SECT	WATER DEPTH
1 2 3 4 5	7 8 9 10	12 13 14 15	17 18 19 20	23 24 25	28 29 30	36 37 38 39 40

EXAMPLE

TYPE PAVEMENT	LONG. SLOPE	TRANS-VERSE SLOPE	SECTION LENGTH	DIST. FROM ℄	DIST. TO START OF DBV SECT	WATER DEPTH
PCC	-1.5	-1.2	2ØØØ	5	3ØØ	.ØØ8

NO DRY MU RUNS	NO. DRY DBV RUNS	NO. TARE RUNS	NO. WET MU RUNS	NO. WET DBV RUNS	DATE (S) OF TEST
44 45	47 48	50 51	53 54	56 57	61 62 63 64 65 66 67 68 69 70 71 72

EXAMPLE

NO DRY MU RUNS	NO. DRY DBV RUNS	NO. TARE RUNS	NO. WET MU RUNS	NO. WET DBV RUNS	DATE (S) OF TEST
2	2		1Ø	8	11-12 NOV 72

NOTES: O = LETTER O
Ø = ZERO
ALL DATA IS RIGHT JUSTIFIED THIS MEANS ANY BLANK SPACES ARE AT LEFT OF FIELD

MU-METER RUNS ON DRY PAVEMENT

BASE ____________________ RUNWAY ____________________

RECORDER ____________________ DATE ____________________

TEST SECTION ____________________

FIRST RUN

RUN DESIGNATION						TIME						C DIAL					B DIAL		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20

SECOND RUN

RUN DESIGNATION						TIME						C DIAL					B DIAL		
21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40

THIRD RUN

RUN DESIGNATION						TIME						C DIAL					B DIAL		
41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60

FOURTH RUN

RUN DESIGNATION						TIME						C DIAL					B DIAL		
61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80

NOTES: O = LETTER O
Ø = ZERO
ALL DATA IS RIGHT JUSTIFIED. THIS MEANS ANY BLANK SPACES ARE AT LEFT OF FIELD.

EXAMPLE

RUN DESIGNATION						TIME						C DIAL					B DIAL		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	A	Ø	1	D	W	1	3	5	6				3	3			1	Ø	2

DBV RUNS ON DRY PAVEMENT

BASE ____________________ RUNWAY ______________

RECORDER ________________ DATE ______________

TEST SECTION ______________

FIRST RUN

RUN DESIGNATION						TIME							VEL mph			STOP DIST			
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20

SECOND RUN

RUN DESIGNATION						TIME							VEL mph			STOP DIST			
21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40

THIRD RUN

RUN DESIGNATION						TIME							VEL mph			STOP. DIST			
41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60

FOURTH RUN

RUN DESIGNATION						TIME							VEL. mph			STOP DIST			
61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80

NOTES: O= LETTER O
Ø= ZERO
ALL DATA IS RIGHT JUSTIFIED. THIS MEANS ANY BLANK SPACES ARE AT LEFT OF FIELD.

EXAMPLE

RUN DESIGNATION						TIME							VEL. mph			STOP DIST.			
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	A	Ø	1	D	E	1	3	5	8				6	1			3	5	5

MU-METER MEASUREMENTS OF PAVEMENT FRICTION ON WET PAVEMENT

AIRFIELD ____________________ RUNWAY ____________________

RECORDER ____________________ DATE ____________________

RUN DESIGNATION							TIME IN										TIME OUT										"C" DIAL					"B" DIAL			INTEGRATED COEF.			
							h			m			s				h			m			s															
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35				

EXAMPLES

A	A	Ø	1	W	N		1	Ø		1	3		1	9			1	Ø		1	3		5	4				3	2			1	Ø	3			3	1
O	O	Ø	1	W	S			9		1	5		2	3				9		1	6		Ø	3				6	3				9	9			6	4
	B	1	Ø	W	S		1	Ø		5	4		2	6			1	Ø		5	4		5	4				6	1				9	6			6	4

NOTES: ZERO = Ø, LETTER = O. ALL DATA IS RIGHT-JUSTIFIED.
THIS MEANS ANY BLANK SPACES ARE AT LEFT OF FIELD.

MU-METER TAPE DATA

AIRFIELD ____________________ RUNWAY ____________________

RECORDER ____________________ DATE ____________________

	MIN. MU, TOTAL SECTION					MAX. MU, TOTAL SECTION					AVG. MU, TOTAL SECTION					MIN. MU, DBV AREA					MAX. MU, DBV AREA					AVG. MU, DBV AREA					RUN DESIGNATION					
36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72

EXAMPLES

			3	Ø				6	Ø				5	Ø				3	5				5	Ø				4	5		A	A	Ø	I	W	N
			3	1				6	2				4	9				4	Ø				5	5				5	Ø		O	O	Ø	I	W	S
			2	5				5	5				4	5				3	Ø				4	5				4	Ø			B	1	Ø	W	S

NOTES: ZERO = Ø, LETTER O = O ALL DATA IS RIGHT-JUSTIFIED.
THIS MEANS ANY BLANK SPACES ARE AT LEFT OF FIELD.

DBV STOPPING TIME AND DISTANCE ON WET PAVEMENT

AIRFIELD ____________________ RUNWAY ____________________

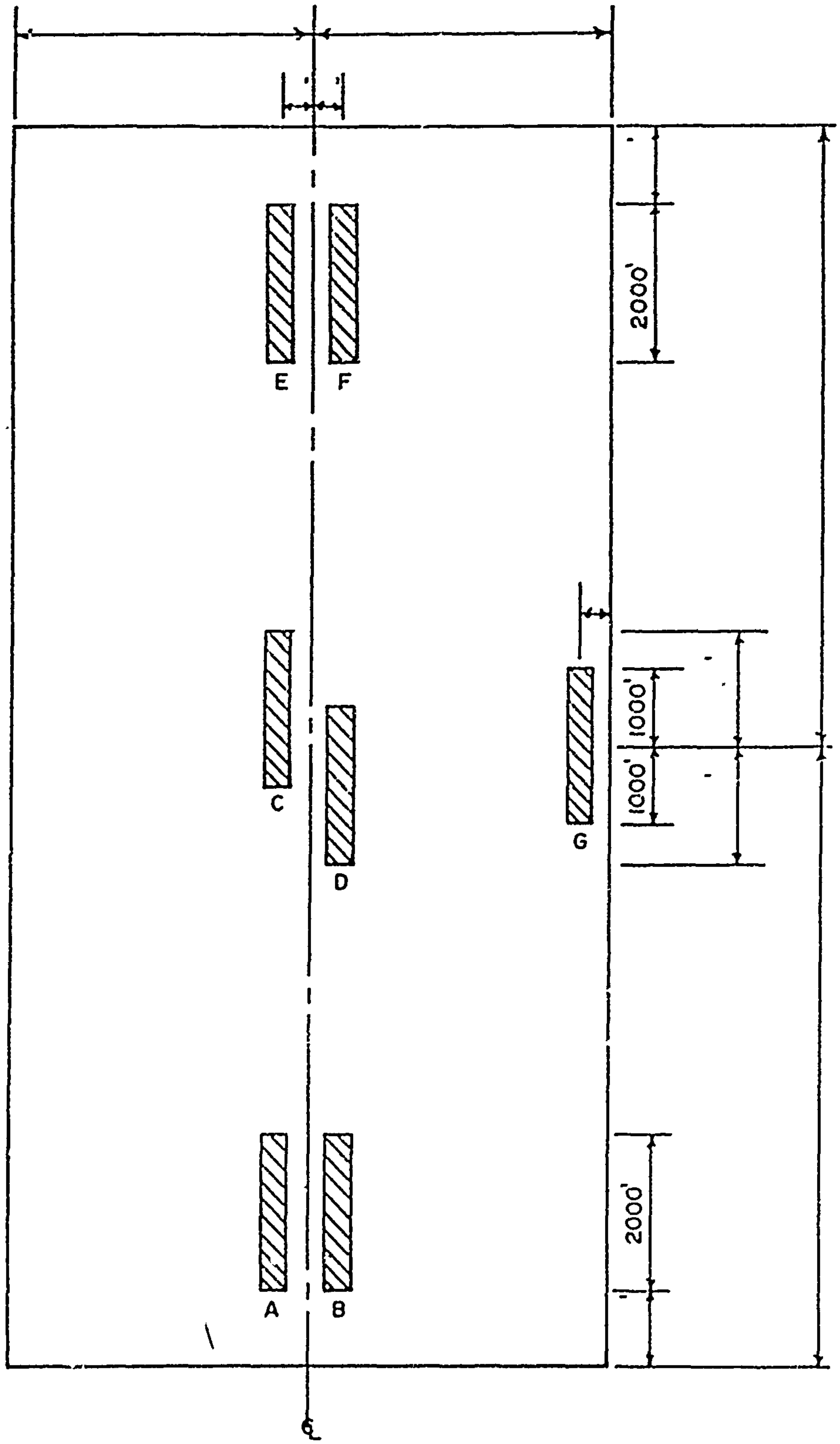
RECORDER ____________________ DATE ____________________

RUN DESIGNATION							LOCK TIME										STOP TIME											TEST SPEED mph				STOP DIST FT.				STOP DIST ADJ. TO 60 MPH			
							h			m			s				h			m			s															
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35				

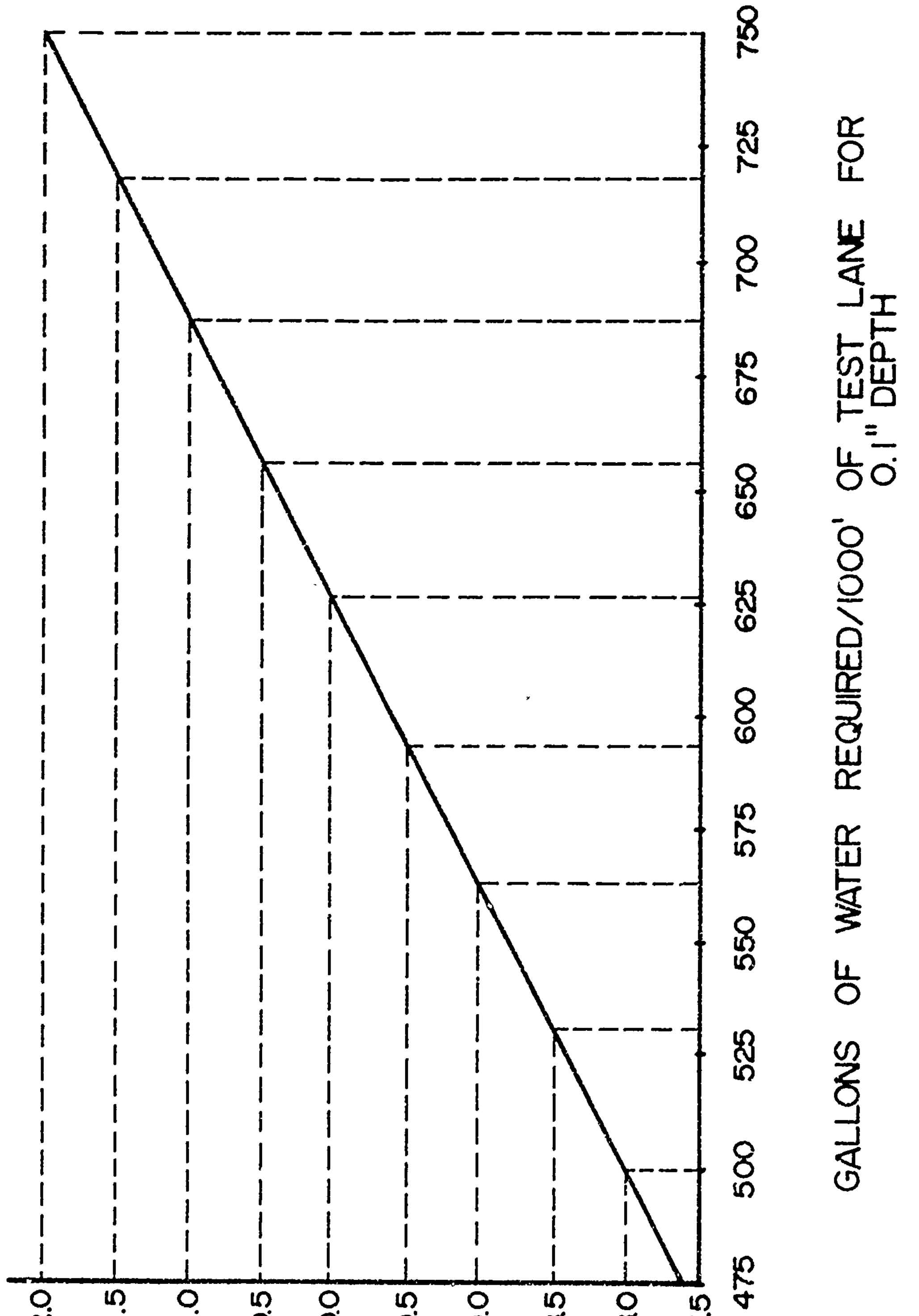
EXAMPLES

A	A	Ø	1	W	S		1	Ø		5	5		2	1			1	Ø		5	5		4	2				6	Ø		1	1	1	6	1	1	1	6
	B	1	Ø	W	N		1	Ø		5	9		Ø	6			1	Ø		5	9		2	3				6	1			3	5	2		3	4	Ø

NOTES: ZERO—Ø, LETTER O—O. ALL DATA IS RIGHT-JUSTIFIED.
THIS MEANS ANY BLANK SPACES ARE AT LEFT OF FIELD



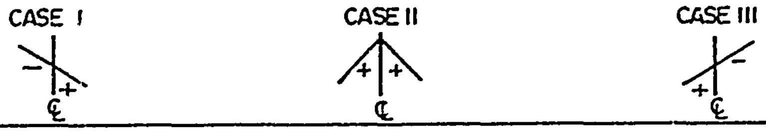
LAYOUT OF TEST STRIPS


SPRAY BAR LENGTH (FT.)
7.5
8.0
8.5
9.0
9.5
10.0
10.5
11.0
11.5
12.0
475
500
525
550
575
600
625
650
675
700
725
750
GALLONS OF WATER REQUIRED/1000' OF TEST LANE FOR 0.1" DEPTH

PAVEMENT CROSS-SLOPE MEASUREMENTS

RECORDER ____________________ RUNWAY ____________________

SIGN CONVENTION



1	2	3	4	5	6	BASE ABBREV.

7	8	9	10	11	12	13	14	15	RUNWAY END (NORTH, ETC)

16	17	18	19	20	NO. LINES USED BELOW

EXAMPLE

SECTION & LIMITS

STATION NO. (R/W DIST. MARKER) (1–6)	7	%SLOPE (8–11)	12	%SLOPE (13–16)	17 ℄	%SLOPE (18–21)	22	%SLOPE (23–26)
Ø+ØØØ								
Ø+5ØØ								
1+ØØØ								
1+5ØØ								
2+ØØØ								
2+5ØØ								
3+ØØØ								
3+5ØØ								
4+ØØØ								
4+5ØØ								
5+ØØØ								
5+5ØØ								
6+ØØØ								
6+5ØØ								
7+ØØØ								
7+5ØØ								
8+ØØØ								
8+5ØØ								
9+ØØØ								
9+5ØØ								
1Ø+ØØØ								
1Ø+5ØØ								
11+ØØØ								
11+5ØØ								
12+ØØØ								
12+5ØØ								
13+ØØØ								
13+5ØØ								
14+ØØØ								
14+5ØØ								
15+ØØØ								
15+5ØØ								

SECTION & LIMITS

B

F

℄

RUNWAY END (SOUTH, ETC)

NOTES:

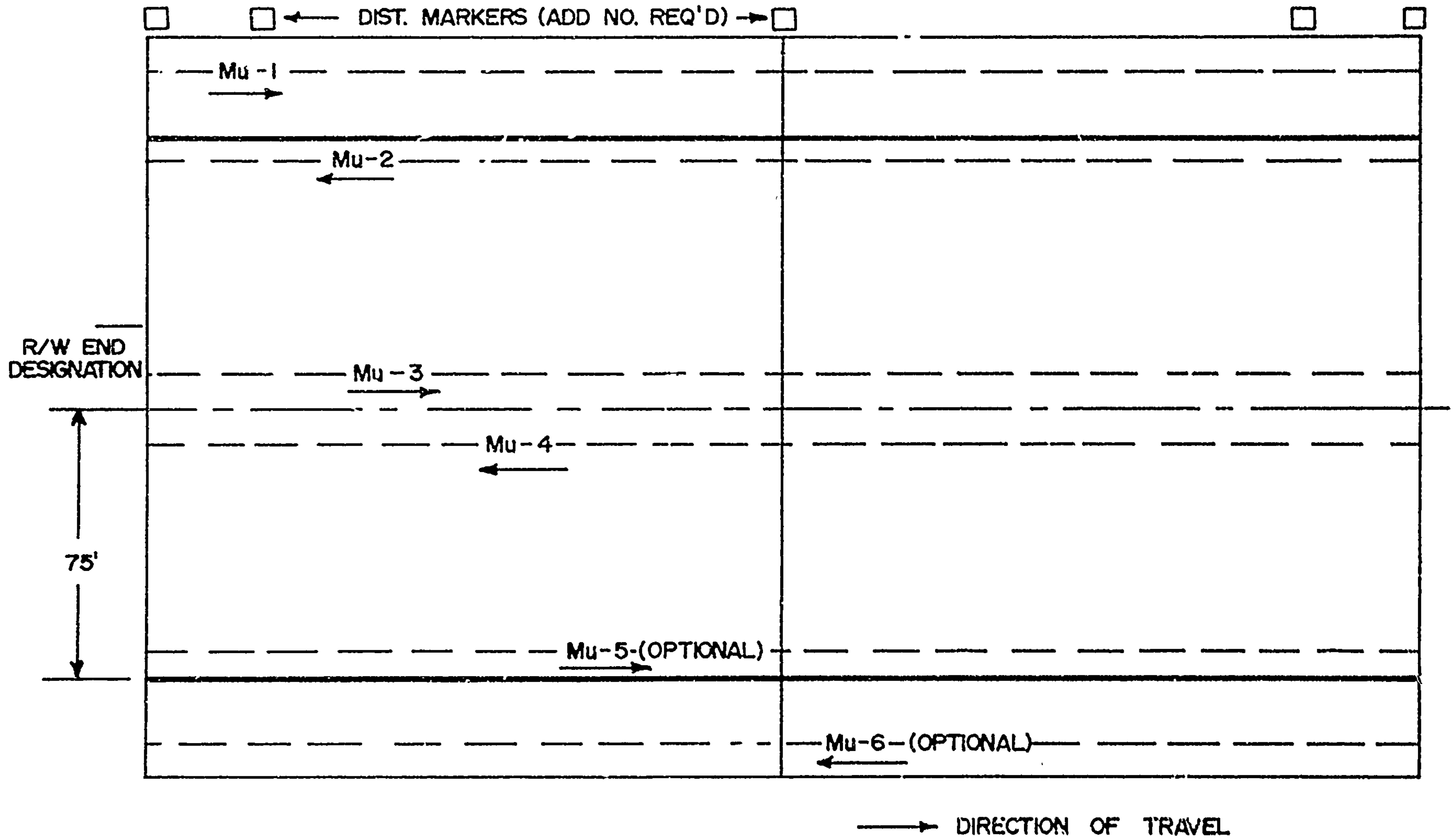
Ø – ZERO

O – LETTER O

Ø+ØØØ	+1.5	+1.4	+1.3	+1.2	EXAMPLE								

Mu-METER DRY RUNS ON ENTIRE PAVEMENT LENGTH

BASE ______________________ RUNWAY ______________________



CONVERSION FACTORS

To Convert a Stopping Distance (SD) at this MPH	Multiply the SD by this Factor
55	1.190
56	1.148
57	1.108
58	1.070
59	1.034
60	1.000
61	0.967
62	0.936
63	0.907
64	0.879
65	0.852

WATER TRUCK CREW BRIEFING CHECK LIST

_____ 1. Does driver know proper tachometer setting to follow?

_____ 2. Does driver know proper gear/axle range to use, and does he understand this cannot be changed during a wetting operation?

_____ 3. Do driver and pump operator understand the layout of the test sections so they both know what area is to be wetted?

_____ 4. Does driver know to make all wetting passes in the same direction, starting the initial pass from the same end the test vehicles will make their initial runs?

_____ 5. Does driver know that upon completion of the final wetting run in each test strip, he should turn sharply out of the way of the test vehicles traveling at 40-60 mph? Direction to be turned will be given by the test conductor.

_____ 6. Does pump operator know to begin water discharge 50 to 100 feet prior to entering the test strip, not to vary the discharge rate in any way, and wet 50 to 100 feet after exiting the test strip?

_____ 7. Is there sufficient fuel to operate the waterpumping system and truck so that no refueling is required during testing sequence?

DBV OPERATION CHECKLIST

BEFORE STARTING ENGINE

______ 1. Check gasoline (use high-test gasoline).

______ 2. Check oil (use 10w30 multigrade oil).

______ 3. Check battery water.

______ 4. Check radiator water.

______ 5. Mount test tires.

______ 6. Check tires (commercial tires: 32 psi; test tires and fifth-wheel tire: 24 $\pm$ 1 psi).

______ 7. Check brake fluid.

______ 8. Check fifth wheel attachment (security) and freedom of movement.

______ 9. Check operation of all lights (roof light, turning lights, headlights, and tail lights).

______ 10. Turn all instrument switches to OFF.

______ 11. Start engine.

CAUTION

Do not back up vehicle with fifth wheel in test position.

AFTER STARTING ENGINE

______ 1. Check engine instruments.

______ 2. Check brake pedal action.

______ 3. Check brake switching valve for free movement and leaks. Return selector valve to four-wheel braking.

CAUTION

When not testing, operate vehicle in four-wheel braking mode only.

______ 4. Turn inverter power switch to ON; check for current dc voltage on each channel on control panel meters by turning power switches to ON.

(a) Channel 1: 12 to 15 v

(b) Channel 2, 3, 4: 6 v

______ 5. Press POWER ON switch to TR-444 recorder. (Light should come on and motor should start running.)

______ 6. Turn power switches for velocity and distance meters to ON.

______ 7. Allow 15 minutes for instruments to warm up.

______ 8. Zero all instruments as follows:

(a) Press reset on velocity and distance meters should clear readout display.

(b) Press test on velocity meter should read 888.

(c) Press test on distance meter should read 8888.

(d) Place AUTO-MAN switch on velocity meter to AUTO-MODE.

(e) Place AUTO-MAN switch on distance meter to AUTO-MODE.

(f) Set amplifier controls to proper setting.

(g) Zero styluses with position control on amplifiers.

______ 9. Set CHART SPEED switch to 1 mm/sec, check JUMP SPEED switch and set stylus heat controls for sharply defined black lines at desired chart speed.

______ 10. Turn all instruments off; turn two-way radio on and set squelch. Turn radio charger to TRICKLE.

PROCEEDING TO TEST AREA

______ 1. Lower fifth wheel to test position; gently apply brakes and check operation of velocity and distance meters.

CAUTION

Do not back up vehicle with fifth wheel in test mode.

______ 2. Switch right-front and left-rear brake valve to OUT. (This gives diagonal braking to left front and right rear.) Gently apply brakes and check torgue to the left. Switch back to normal four-wheel braking. Switch left-front and right-rear brake valve to OUT. (This

gives diagonal braking to right front and left rear). Gently apply brakes and check for torque to the right. Switch back to four-wheel mode.

AT TEST AREA

_____ 1. Inform test conductor that vehicle is ready for test.

_____ 2. Follow established vehicle-control procedures.

_____ 3. Examine and assess test zone entrance and exit for possible emergency action.

_____ 4. With brakes fully released, close brake valve to road tires. Apply full brake pressure and check for leakage of brake system.

_____ 5. Turn on roof warning light.

_____ 6. Proceed to acceleration point.

AT ACCELERATION POINT

_____ 1. Lower fifth wheel to test position.

_____ 2. Put safety belts and safety helmet on and confirm that all items are tied down.

_____ 3. Turn inverter power on.

_____ 4. Turn recorder power on.

_____ 5. Turn gage power on and set at zero.

AMPLIFIER SETTINGS:

A. Accelerometers at 50 mv/div.

B. Pressure transducer at 20 mv/div.

_____ 6. Turn distance and velocity meter power on and reset to zero.

_____ 7. Check that valve to pressure gage is on.

_____ 8. Check that manifold brake valves are in DBV mode.

_____ 9. Start recorder at 1 mm/sec; apply electric calibrate to all channels.

DURING TEST RUN

______ 1. Accelerate test vehicle to 5 mph above test speed.

______ 2. Change recorder speed to 10 mm/sec with JUMP SPEED switch.

NOTE

Steps 2 and 3 should occur at point where vehicle speed drops to proper speed for testing just as all four wheels of vehicle enter test zone.

______ 4. Allow vehicle to coast into test zone; when velocity meter indicates proper speed after entering test zone, stamp on brake pedal and hold down hard.

NOTE

Test wheels must lock up and remain locked for duration of test to be of any value. At lock up there will be a slight torque on the steering in the direction of the front wheel that is locked, so be prepared for this.

______ 5. Hold pedal down hard until all data are recorded.

AFTER STOPPING VEHICLE

______ 1. Stop recorder.

______ 2. Read and record distance meter reading.

______ 3. Read and record velocity meter reading.

NOTE

This must be done before releasing the brake pedal as this clears the velocity reading.

______ 4. Take foot off brake pedal.

______ 5. Return brake valve to normal four-wheel mode.

CAUTION

Do not operate vehicle in diagonal-brake mode when not in test zone.

______ 6. Clear test zone as instructed.